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(54) **FACET JOINT IMPLANTS AND DELIVERY TOOLS**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

1,934,962	A	11/1933	Barry
2,708,376	A	5/1955	Booth

(Continued)

FOREIGN PATENT DOCUMENTS

DE	G9304368.6 U1	5/2003	
FR	2722980 A1	2/1996	

(Continued)

OTHER PUBLICATIONS

US 7,063,700, 06/2006, Michelson (withdrawn)

(Continued)

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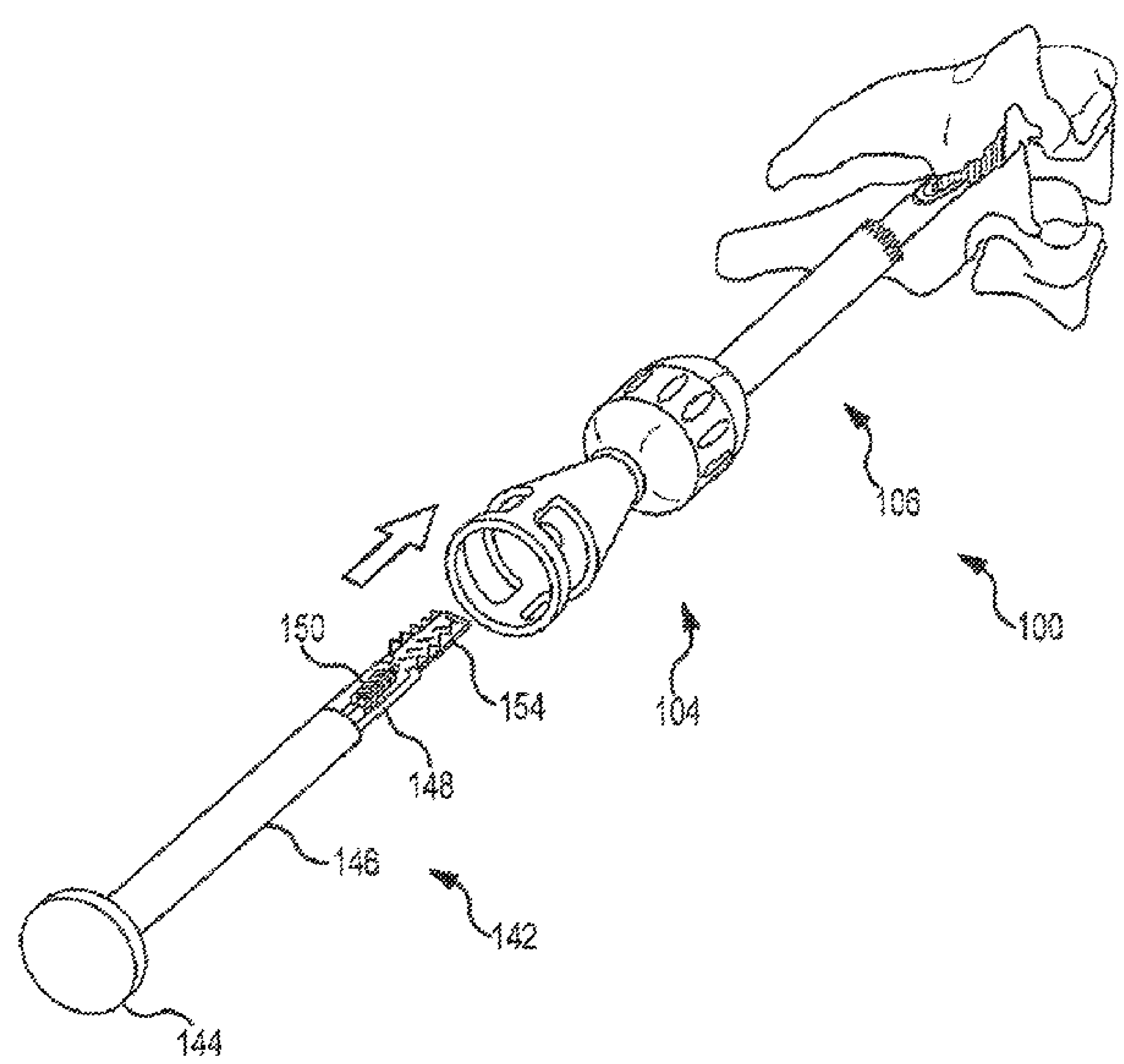
(57) **ABSTRACT**

A spinal joint distraction system is disclosed and may include a driver assembly with a tubular shaft, a pair of implant holder arms, an implant distractor, an internal actuator, and a distractor knob, the system also including a delivery device with a tubular shaft, a receiving assembly, and a pair of forks, where the delivery device is adapted for slidable insertion of the driver assembly, the system also including an implant, a chisel, and an injector. Several embodiments of an implant are disclosed as well a method of placing an implant.

8 Claims, 81 Drawing Sheets



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(56) **References Cited**

U.S. PATENT DOCUMENTS

2,984,241	A	5/1961	Carlson
4,479,491	A	10/1984	Martin
4,530,355	A	7/1985	Griggs
4,604,995	A	8/1986	Stephens et al.
4,772,287	A	9/1988	Ray et al.
4,877,020	A	10/1989	Vich
4,878,915	A	11/1989	Brantigan
5,015,247	A	5/1991	Michelson
5,026,373	A	6/1991	Ray et al.
5,100,405	A	3/1992	McLaren
5,135,528	A	8/1992	Winston
5,236,460	A	8/1993	Barber
5,484,437	A	1/1996	Michelson
5,489,307	A	2/1996	Kuslich et al.
5,505,732	A	4/1996	Michelson
5,527,312	A	6/1996	Ray
5,549,679	A	8/1996	Kuslich et al.
5,554,191	A	9/1996	Lahille et al.
5,571,191	A	11/1996	Fitz
5,584,832	A	12/1996	Schlapfer et al.
5,593,409	A	1/1997	Michelson
5,632,747	A	5/1997	Scarborough et al.
5,649,945	A	7/1997	Ray et al.
5,653,763	A	8/1997	Errico et al.
5,665,122	A	9/1997	Kambin
5,674,295	A	10/1997	Ray et al.
5,720,748	A	2/1998	Kuslich et al.
5,741,253	A	4/1998	Michelson
5,772,661	A	6/1998	Michelson
5,792,044	A	8/1998	Foley et al.
5,797,909	A	8/1998	Michelson
5,836,948	A	11/1998	Zucherman et al.
5,879,353	A	3/1999	Terry
5,885,299	A	3/1999	Winslow et al.
5,891,147	A	4/1999	Moskovitz
5,895,426	A	4/1999	Scarborough et al.
5,899,908	A	5/1999	Kuslich et al.
5,928,238	A	7/1999	Scarborough et al.
5,953,820	A	9/1999	Vasudeva
5,961,522	A	10/1999	Mehdizadeh
5,976,146	A	11/1999	Ogawa
6,008,433	A	12/1999	Stone
6,033,405	A	3/2000	Winslow et al.
6,045,580	A	4/2000	Scarborough et al.
6,063,088	A	5/2000	Winslow
RE36,758	E	6/2000	Fitz
6,080,155	A	6/2000	Michelson
6,090,143	A	7/2000	Meriwether et al.
6,096,038	A	8/2000	Michelson
6,099,531	A	8/2000	Bonutti
6,102,950	A	8/2000	Vaccaro
6,113,602	A	9/2000	Sand
6,149,650	A	11/2000	Michelson
RE37,005	E	12/2000	Michelson et al.
6,159,245	A	12/2000	Meriwether et al.
6,176,882	B1	1/2001	Biedermann et al.
6,179,873	B1	1/2001	Zientek
6,190,388	B1	2/2001	Michelson et al.
6,190,414	B1	2/2001	Young et al.
6,193,757	B1	2/2001	Foley et al.
6,210,412	B1	4/2001	Michelson
RE37,161	E	5/2001	Michelson et al.
6,224,595	B1	5/2001	Michelson
6,224,607	B1	5/2001	Michelson
6,224,630	B1	5/2001	Bao et al.
6,245,108	B1	6/2001	Biscup
6,248,110	B1	6/2001	Reiley et al.
D444,878	S	7/2001	Walter
D445,188	S	7/2001	Walter
6,264,656	B1	7/2001	Michelson
6,267,763	B1	7/2001	Castro
6,270,498	B1	8/2001	Michelson
6,283,966	B1	9/2001	Boufburg
6,315,795	B1	11/2001	Scarborough et al.
6,325,827	B1	12/2001	Lin
6,371,984	B1	4/2002	Van Dyke et al.
6,371,988	B1	4/2002	Pafford et al.
6,402,784	B1	6/2002	Wardlaw
6,423,063	B1	7/2002	Bonutti
6,423,083	B2	7/2002	Reiley et al.
6,425,919	B1	7/2002	Lambrecht
6,436,098	B1	8/2002	Michelson
6,436,142	B1	8/2002	Paes et al.
6,443,988	B2	9/2002	Felt et al.
6,451,023	B1	9/2002	Salazar et al.
6,454,807	B1	9/2002	Jackson
6,478,796	B2	11/2002	Zucherman et al.
6,500,206	B1	12/2002	Bryan
6,514,256	B2	2/2003	Zucherman et al.
6,530,955	B2	3/2003	Boyle et al.
6,558,390	B2	5/2003	Cragg
6,565,574	B2	5/2003	Michelson
6,565,605	B2	5/2003	Fallin et al.
6,569,186	B1	5/2003	Winters et al.
6,575,919	B1	6/2003	Reiley et al.
6,575,979	B1	6/2003	Cragg
6,579,319	B2	6/2003	Goble et al.
6,582,432	B1	6/2003	Michelson
6,607,530	B1	8/2003	Carl et al.
6,610,091	B1	8/2003	Reiley
6,626,905	B1	9/2003	Schmiel et al.
6,632,235	B2	10/2003	Weikel et al.
6,635,060	B2	10/2003	Hanson et al.
6,641,582	B1	11/2003	Hanson et al.
6,648,893	B2	11/2003	Dudasik
6,652,584	B2	11/2003	Michelson
6,663,647	B2	12/2003	Reiley et al.
6,666,866	B2	12/2003	Martz et al.
6,679,886	B2	1/2004	Weikel et al.
6,682,535	B2	1/2004	Hoogland
6,685,742	B1	2/2004	Jackson
6,709,458	B2	3/2004	Michelson
6,712,853	B2	3/2004	Kuslich
6,719,773	B1	4/2004	Boucher et al.
6,723,095	B2	4/2004	Hammerslag
6,733,534	B2	5/2004	Sherman
6,740,093	B2	5/2004	Hochschuler et al.
6,751,875	B2	6/2004	Jones
6,770,074	B2	8/2004	Michelson
6,793,679	B2	9/2004	Michelson
6,805,715	B2	10/2004	Reuter et al.
6,808,537	B2	10/2004	Michelson
6,823,871	B2	11/2004	Schmieding
6,840,941	B2	1/2005	Rogers et al.
6,851,430	B2	2/2005	Tsou

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,875,213 B2 4/2005 Michelson
6,899,719 B2 5/2005 Reiley et al.
6,921,403 B2 7/2005 Cragg et al.
6,923,813 B2 8/2005 Phillips et al.
6,958,077 B2 10/2005 Suddaby
6,962,606 B2 11/2005 Michelson
6,964,686 B2 11/2005 Gordon
6,966,930 B2 11/2005 Arnin et al.
6,972,035 B2 12/2005 Michelson
6,974,478 B2 12/2005 Reiley et al.
6,979,333 B2 12/2005 Hammerslag
6,986,772 B2 1/2006 Michelson
7,001,385 B2 2/2006 Bonutti
7,008,453 B1 3/2006 Michelson
7,033,362 B2 4/2006 McGahan et al.
7,033,392 B2 4/2006 Schmiel et al.
7,033,394 B2 4/2006 Michelson
7,066,961 B2 6/2006 Michelson
D524,443 S 7/2006 Blain
7,083,623 B2 8/2006 Michelson
7,090,698 B2 8/2006 Fallin et al.
7,096,972 B2 8/2006 Orozco, Jr.
7,101,398 B2 9/2006 Dooris et al.
7,115,128 B2 10/2006 Michelson
7,118,598 B2 10/2006 Michelson
7,128,760 B2 10/2006 Michelson
7,156,877 B2 1/2007 Lotz et al.
7,166,110 B2 1/2007 Yundt
7,175,023 B2 2/2007 Martin
7,179,263 B2 2/2007 Zdeblick et al.
7,207,991 B2 4/2007 Michelson
D541,940 S 5/2007 Blain
7,220,280 B2 5/2007 Kast et al.
7,264,622 B2 9/2007 Michelson
7,273,498 B2 9/2007 Bianchi et al.
7,288,093 B2 10/2007 Michelson
7,291,149 B1 11/2007 Michelson
7,300,440 B2 11/2007 Zdeblick et al.
7,326,211 B2 2/2008 Padget et al.
7,326,214 B2 2/2008 Michelson
7,371,238 B2 5/2008 Soboleski et al.
7,399,303 B2 7/2008 Michelson
7,410,501 B2 8/2008 Michelson
7,431,722 B1 10/2008 Michelson
7,445,636 B2 11/2008 Michelson
7,452,359 B1 11/2008 Michelson
7,452,369 B2 11/2008 Barry
7,465,304 B1 12/2008 Haufe et al.
7,476,226 B2 1/2009 Weikel et al.
7,476,251 B2 1/2009 Zucherman et al.
7,479,160 B2 1/2009 Branch et al.
7,491,205 B1 2/2009 Michelson
7,500,992 B2 3/2009 Li
7,517,358 B2 4/2009 Peterson
7,524,333 B2 4/2009 Lambrecht et al.
7,569,054 B2 8/2009 Michelson
7,569,057 B2 8/2009 Liu et al.
7,580,743 B2 8/2009 Bourlion et al.
7,591,851 B2 9/2009 Winslow et al.
7,601,170 B2 10/2009 Winslow et al.
7,608,077 B2 10/2009 Cragg et al.
7,608,107 B2 10/2009 Michelson
7,615,079 B2 11/2009 Flickinger et al.
7,618,451 B2 11/2009 Berez et al.
7,632,291 B2 12/2009 Stephens et al.
7,641,664 B2 1/2010 Pagano
7,648,523 B2 1/2010 Mirkovic et al.
7,655,027 B2 2/2010 Michelson
7,655,043 B2 2/2010 Peterman et al.
7,662,173 B2 2/2010 Cragg et al.
D611,147 S 3/2010 Hanson et al.
7,682,378 B2 3/2010 Truckai et al.
7,686,805 B2 3/2010 Michelson
7,686,807 B2 3/2010 Padget et al.
7,699,878 B2 4/2010 Pavlov et al.
D615,653 S 5/2010 Horton
7,708,761 B2 5/2010 Petersen
7,722,619 B2 5/2010 Michelson
D619,719 S 7/2010 Pannu
7,763,024 B2 7/2010 Bertagnoli et al.
7,763,050 B2 7/2010 Winslow et al.
7,776,090 B2 8/2010 Winslow et al.
D623,748 S 9/2010 Horton et al.
D623,749 S 9/2010 Horton et al.
7,789,898 B2 9/2010 Peterman
D627,468 S 11/2010 Richter et al.
7,824,431 B2 11/2010 McCormack
7,837,713 B2 11/2010 Peterson
7,846,183 B2 12/2010 Blain
7,846,184 B2 12/2010 Sasso et al.
7,850,733 B2 12/2010 Baynham et al.
7,862,589 B2 1/2011 Thramann
7,867,277 B1 1/2011 Tohmeh
D631,967 S 2/2011 Horton
7,879,098 B1 2/2011 Simmons, Jr.
7,887,565 B2 2/2011 Michelson
7,892,261 B2 2/2011 Bonutti
7,892,286 B2 2/2011 Michelson
7,896,803 B2 3/2011 Schara et al.
7,896,903 B2 3/2011 Link
7,901,439 B2 3/2011 Horton
7,914,530 B2 3/2011 Michelson
7,918,891 B1 4/2011 Curran et al.
7,922,729 B2 4/2011 Michelson
7,922,766 B2 4/2011 Grob et al.
7,935,136 B2 5/2011 Alamin et al.
7,938,857 B2 5/2011 Krueger et al.
7,988,712 B2 8/2011 Hale et al.
7,988,714 B2 8/2011 Puekert et al.
7,998,174 B2 8/2011 Malandain et al.
8,007,534 B2 8/2011 Michelson
8,029,540 B2 10/2011 Winslow et al.
8,043,334 B2 10/2011 Fisher et al.
8,052,728 B2 11/2011 Hestad
8,062,303 B2 11/2011 Berry et al.
8,066,705 B2 11/2011 Michelson
D650,481 S 12/2011 Gottlieb et al.
8,097,034 B2 1/2012 Michelson
8,100,944 B2 1/2012 Lauryssen et al.
D653,757 S 2/2012 Binder
8,114,158 B2 2/2012 Carl et al.
8,118,838 B2 2/2012 Winslow et al.
8,128,660 B2 3/2012 Mitchel et al.
8,133,261 B2 3/2012 Fisher et al.
8,142,503 B2 3/2012 Malone
8,147,553 B2 4/2012 Vresilovic et al.
8,162,981 B2 4/2012 Vestgaarden
8,172,877 B2 5/2012 Winslow et al.
8,177,872 B2 5/2012 Nelson et al.
8,197,513 B2 6/2012 Fisher et al.
8,206,418 B2 6/2012 Triplett et al.
8,267,966 B2 9/2012 McCormack et al.
D674,900 S 1/2013 Janice et al.
8,348,979 B2 1/2013 McCormack
8,361,152 B2 1/2013 McCormack et al.
8,366,748 B2 2/2013 Kleiner
D677,791 S 3/2013 Danacioglu et al.
8,394,107 B2 3/2013 Fanger et al.
8,394,129 B2 3/2013 Morgenstern et al.
D681,205 S 4/2013 Farris et al.
8,425,558 B2 4/2013 McCormack et al.
8,512,347 B2 8/2013 McCormack et al.
8,523,908 B2 9/2013 Malone
8,623,054 B2 1/2014 McCormack et al.
8,668,722 B2 3/2014 Pavlov et al.
8,753,347 B2 6/2014 McCormack et al.
8,764,755 B2 7/2014 Michelson
8,828,062 B2 9/2014 McCormack et al.
8,834,530 B2 9/2014 McCormack
8,845,727 B2 9/2014 Gottlieb et al.
8,870,882 B2 10/2014 Kleiner
D723,690 S 3/2015 McCormack et al.
D723,691 S 3/2015 McCormack et al.
8,998,905 B2 4/2015 Marik et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,011,492	B2 *	4/2015	McCormack	A61B 17/025 606/247
D732,667	S	6/2015	McCormack et al.	
D745,156	S	12/2015	McCormack et al.	
9,211,198	B2	12/2015	Michelson	
9,220,608	B2	12/2015	McKay	
D750,249	S	2/2016	Grimberg et al.	
9,271,765	B2	3/2016	Blain	
9,333,086	B2	5/2016	McCormack et al.	
9,381,049	B2	7/2016	McCormack et al.	
9,427,264	B2	8/2016	Kleiner et al.	
9,504,583	B2	11/2016	Blain et al.	
9,717,403	B2	8/2017	Kleiner et al.	
2001/0004710	A1	6/2001	Felt et al.	
2001/0047208	A1	11/2001	Michelson et al.	
2002/0026195	A1	2/2002	Layne et al.	
2002/0107519	A1	8/2002	Dixon et al.	
2002/0143343	A1	10/2002	Castro	
2002/0147496	A1	10/2002	Belef et al.	
2002/0147497	A1	10/2002	Belef et al.	
2002/0165612	A1	11/2002	Gerber et al.	
2002/0169471	A1	11/2002	Ferdinand	
2003/0023312	A1	1/2003	Thalgott et al.	
2003/0028251	A1	2/2003	Mathews	
2003/0032962	A1	2/2003	McGahan et al.	
2003/0033017	A1	2/2003	Lotz et al.	
2003/0105526	A1	6/2003	Bryant et al.	
2003/0109928	A1	6/2003	Pasquet et al.	
2003/0139816	A1	7/2003	Michelson	
2003/0144737	A1	7/2003	Sherman	
2003/0158553	A1	8/2003	Michelson	
2003/0225416	A1	12/2003	Bonvallet et al.	
2004/0059337	A1	3/2004	Hanson et al.	
2004/0073217	A1	4/2004	Michelson	
2004/0087948	A1	5/2004	Suddaby	
2004/0087956	A1	5/2004	Weikel et al.	
2004/0106999	A1	6/2004	Mathews	
2004/0133277	A1	7/2004	Michelson	
2004/0133280	A1	7/2004	Trieu	
2004/0162562	A1	8/2004	Martz	
2004/0215344	A1	10/2004	Hochshculer et al.	
2005/0010294	A1	1/2005	Michelson	
2005/0015149	A1	1/2005	Michelson	
2005/0027358	A1	2/2005	Suddaby	
2005/0033432	A1	2/2005	Gordon et al.	
2005/0049705	A1	3/2005	Hale et al.	
2005/0055096	A1	3/2005	Serhan et al.	
2005/0065518	A1	3/2005	Michelson	
2005/0065519	A1	3/2005	Michelson	
2005/0065608	A1	3/2005	Michelson	
2005/0065609	A1	3/2005	Wardlaw	
2005/0080422	A1	4/2005	Otte et al.	
2005/0090829	A1	4/2005	Martz et al.	
2005/0090901	A1	4/2005	Studer	
2005/0119680	A1	6/2005	Dykes	
2005/0124993	A1	6/2005	Chappuis	
2005/0159650	A1	7/2005	Raymond et al.	
2005/0159746	A1	7/2005	Grob et al.	
2005/0177240	A1	8/2005	Blain	
2005/0182417	A1	8/2005	Pagano	
2005/0216018	A1	9/2005	Sennett	
2005/0240188	A1	10/2005	Chow et al.	
2005/0251146	A1	11/2005	Martz et al.	
2005/0251257	A1	11/2005	Mitchell et al.	
2005/0267480	A1	12/2005	Suddaby	
2006/0004367	A1	1/2006	Alamin et al.	
2006/0015184	A1	1/2006	Winterbottom et al.	
2006/0036243	A1	2/2006	Sasso et al.	
2006/0036247	A1	2/2006	Michelson	
2006/0036323	A1	2/2006	Carl et al.	
2006/0041311	A1	2/2006	McLeer	
2006/0058793	A1	3/2006	Michelson	
2006/0058878	A1	3/2006	Michelson	
2006/0069442	A1	3/2006	Michelson	
2006/0079905	A1	4/2006	Beyar et al.	
2006/0079962	A1	4/2006	Michelson	
2006/0085068	A1	4/2006	Barry et al.	
2006/0085074	A1	4/2006	Raiszadeh	
2006/0095028	A1	5/2006	Bleich	
2006/0095036	A1	5/2006	Hammerslag	
2006/0111779	A1	5/2006	Peterson	
2006/0111780	A1	5/2006	Petersen	
2006/0111781	A1	5/2006	Petersen	
2006/0142762	A1	6/2006	Michelson	
2006/0149289	A1	7/2006	Winslow et al.	
2006/0184172	A1	8/2006	Michelson	
2006/0190081	A1	8/2006	Kraus et al.	
2006/0195109	A1	8/2006	McGahan et al.	
2006/0200137	A1	9/2006	Soboleski et al.	
2006/0200138	A1	9/2006	Michelson	
2006/0200139	A1	9/2006	Michelson	
2006/0206118	A1	9/2006	Kim et al.	
2006/0217812	A1	9/2006	Lambrecht et al.	
2006/0235391	A1	10/2006	Sutterlin, III	
2006/0241597	A1	10/2006	Mitchell et al.	
2006/0241626	A1	10/2006	McGahan et al.	
2006/0241758	A1	10/2006	Peterman et al.	
2006/0247632	A1	11/2006	Winslow et al.	
2006/0247633	A1	11/2006	Winslow et al.	
2006/0247650	A1	11/2006	Yerby et al.	
2006/0259142	A1	11/2006	Dooris et al.	
2006/0271195	A1	11/2006	Thramann	
2006/0276790	A1	12/2006	Dawson et al.	
2006/0276801	A1	12/2006	Yerby et al.	
2006/0276897	A1	12/2006	Winslow et al.	
2006/0293663	A1	12/2006	Walkenhorst et al.	
2007/0016195	A1	1/2007	Winslow et al.	
2007/0016196	A1	1/2007	Winslow et al.	
2007/0016218	A1	1/2007	Winslow et al.	
2007/0032871	A1	2/2007	Michelson	
2007/0043362	A1	2/2007	Malandain et al.	
2007/0050031	A1	3/2007	Khosrowshahi	
2007/0055245	A1	3/2007	Sasso et al.	
2007/0055263	A1	3/2007	Way et al.	
2007/0073402	A1	3/2007	Vresilovic et al.	
2007/0083265	A1	4/2007	Malone	
2007/0123863	A1	5/2007	Winslow et al.	
2007/0123888	A1	5/2007	Bleich et al.	
2007/0135814	A1	6/2007	Farris	
2007/0135921	A1	6/2007	Park	
2007/0149976	A1	6/2007	Hale et al.	
2007/0149983	A1	6/2007	Link	
2007/0150061	A1	6/2007	Trieu	
2007/0161991	A1	7/2007	Altarac et al.	
2007/0179617	A1	8/2007	Brown et al.	
2007/0179619	A1	8/2007	Grob et al.	
2007/0225721	A1	9/2007	Thelen et al.	
2007/0225812	A1	9/2007	Gill	
2007/0244483	A9	10/2007	Winslow et al.	
2007/0276491	A1	11/2007	Ahrens	
2007/0282441	A1	12/2007	Stream et al.	
2007/0288014	A1	12/2007	Shadduck et al.	
2007/0299451	A1	12/2007	Tulkis	
2008/0015581	A1	1/2008	Eckman et al.	
2008/0021457	A1	1/2008	Anderson et al.	
2008/0021464	A1	1/2008	Morin et al.	
2008/0058954	A1	3/2008	Trieu	
2008/0065219	A1	3/2008	Dye	
2008/0097436	A1	4/2008	Culbert et al.	
2008/0108996	A1	5/2008	Padget et al.	
2008/0140207	A1	6/2008	Olmos et al.	
2008/0161810	A1	7/2008	Melkent	
2008/0161929	A1	7/2008	McCormack et al.	
2008/0167657	A1	7/2008	Greenhaigh	
2008/0177311	A1	7/2008	Winslow et al.	
2008/0208341	A1	8/2008	McCormack et al.	
2008/0216846	A1	9/2008	Levin	
2008/0234677	A1	9/2008	Dahners et al.	
2008/0234758	A1	9/2008	Fisher et al.	
2008/0255564	A1	10/2008	Michelson	
2008/0255618	A1	10/2008	Fisher et al.	
2008/0255622	A1	10/2008	Mickiewicz et al.	
2008/0255666	A1	10/2008	Fisher et al.	
2008/0255667	A1	10/2008	Horton	

(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0287955	A1	11/2008	Michelson
2008/0306537	A1	12/2008	Culbert
2008/0312744	A1	12/2008	Vresilovic et al.
2009/0131986	A1	5/2009	Lee et al.
2009/0138053	A1	5/2009	Assell et al.
2009/0177205	A1	7/2009	McCormack et al.
2009/0177237	A1	7/2009	Zucherman et al.
2009/0234397	A1	9/2009	Petersen
2009/0248076	A1	10/2009	Reynolds et al.
2009/0263461	A1	10/2009	McKay
2009/0270929	A1	10/2009	Suddaby et al.
2009/0275994	A1	11/2009	Phan et al.
2009/0306671	A1	12/2009	McCormack et al.
2009/0312763	A1	12/2009	McCormack et al.
2010/0069912	A1	3/2010	McCormack et al.
2010/0086185	A1	4/2010	Weiss
2010/0093829	A1	4/2010	Gorman
2010/0114318	A1	5/2010	Gittings et al.
2010/0145391	A1	6/2010	Kleiner
2010/0191241	A1	7/2010	McCormack et al.
2011/0004247	A1	1/2011	Lechmann et al.
2011/0022089	A1	1/2011	Assell et al.
2011/0054613	A1	3/2011	Hansen
2011/0077686	A1	3/2011	Mishra et al.
2011/0082548	A1	4/2011	Assell et al.
2011/0144755	A1	6/2011	Baynham et al.
2011/0190821	A1	8/2011	Chin et al.
2011/0245930	A1	10/2011	Alley et al.
2011/0295327	A1	12/2011	Moskowitz et al.
2011/0307061	A1	12/2011	Assell et al.
2012/0010659	A1	1/2012	Angert et al.
2012/0010662	A1	1/2012	O'Neil et al.
2012/0010669	A1	1/2012	O'Neil et al.
2012/0065613	A1	3/2012	Pepper et al.
2012/0143334	A1	6/2012	Boyce et al.
2012/0215259	A1	8/2012	Cannestra
2012/0265250	A1	10/2012	Ali
2012/0283776	A1	11/2012	Mishra
2012/0323242	A1	12/2012	Tsuang et al.
2013/0006364	A1	1/2013	McCormack et al.
2013/0012994	A1	1/2013	McCormack et al.
2013/0013070	A1	1/2013	McCormack et al.
2013/0018474	A1	1/2013	McCormack et al.
2013/0023995	A1	1/2013	McCormack et al.
2013/0023996	A1	1/2013	McCormack et al.
2013/0030440	A1	1/2013	McCormack et al.
2013/0030532	A1	1/2013	McCormack et al.
2013/0110168	A1	5/2013	McCormack et al.
2013/0110243	A1	5/2013	Patterson et al.
2013/0123922	A1	5/2013	McCormack et al.
2013/0144389	A1	6/2013	Bonutti
2013/0226239	A1	8/2013	Altarac et al.
2013/0253649	A1	9/2013	Davis
2013/0274763	A1	10/2013	Drapeau et al.
2013/0310839	A1	11/2013	McCormack et al.
2013/0310878	A1	11/2013	McCormack et al.
2013/0310943	A1	11/2013	McCormack et al.
2013/0317548	A1	11/2013	Malone
2013/0338720	A1	12/2013	Kleiner
2014/0025113	A1	1/2014	McCormack et al.
2014/0100657	A1	4/2014	McCormack et al.
2014/0379087	A1	12/2014	McCormack
2015/0297357	A1	10/2015	McCormack et al.
2017/0027713	A1	2/2017	Kleiner
2017/0189199	A1	7/2017	Maier et al.
2017/0216044	A1	8/2017	McCormack

FOREIGN PATENT DOCUMENTS

WO	9641582	A1	12/1996
WO	99/49818	A1	10/1999
WO	00/035388	A1	6/2000
WO	00/53126	A1	9/2000
WO	0053126	A1	9/2000
WO	01/01895	A1	1/2001
WO	02/34120	A2	5/2002
WO	02/38062	A2	5/2002
WO	0234120	A2	5/2002
WO	02/076335	A2	10/2002
WO	2006058221	A2	6/2006
WO	2006130791	A2	12/2006
WO	2007120903	A2	10/2007
WO	2008083349	A1	7/2008
WO	2008153732	A1	12/2008
WO	2009089367	A2	7/2009
WO	2009148619	A2	12/2009
WO	2010030994	A2	3/2010
WO	2010074714	A2	7/2010
WO	2016049784	A1	4/2016

OTHER PUBLICATIONS

Stein et al., "Percuraneous Facet Joint Fusion: Preliminary Experience," Journal of Vascular and Interventional Radiology, Jan.-Feb. 1993, pp. 69-74, vol. 4, No. 1.

Goel, Atul, "Facetal distraction as treatment for single- and multilevel cervical spondylotic radiculopathy and myelopathy: a preliminary report", J Neurosurg Spine, Jun. 2011, pp. 689-696.

International Search Report and Written Opinion, International patent application No. PCT/US2009/003423, Dec. 14, 2009, pp. 1-16.

Partial International Search Report, International patent application No. PCT/US2009/003423, dated Sep. 14, 2009, pp. 1-3.

Press Release, Interventional Spine, Inc., Interventional Spine, Inc. Introduces the PERPOS Fusion Facet Prep Kit, Oct. 14, 2008, 1 Page.

Press Release, minSURG Corp., Orthopedic Development Corporation's TruFUSE Procedure Tops 1,750 Patients in First Year, Sep. 24, 2007, 1 Page.

Press Release , Interventional Spine, Inc., FDA Grants Conditional Approval to Interventional Spine's PercuDyn System IDE Application, Jul. 1, 2008, 1 Page.

* cited by examiner

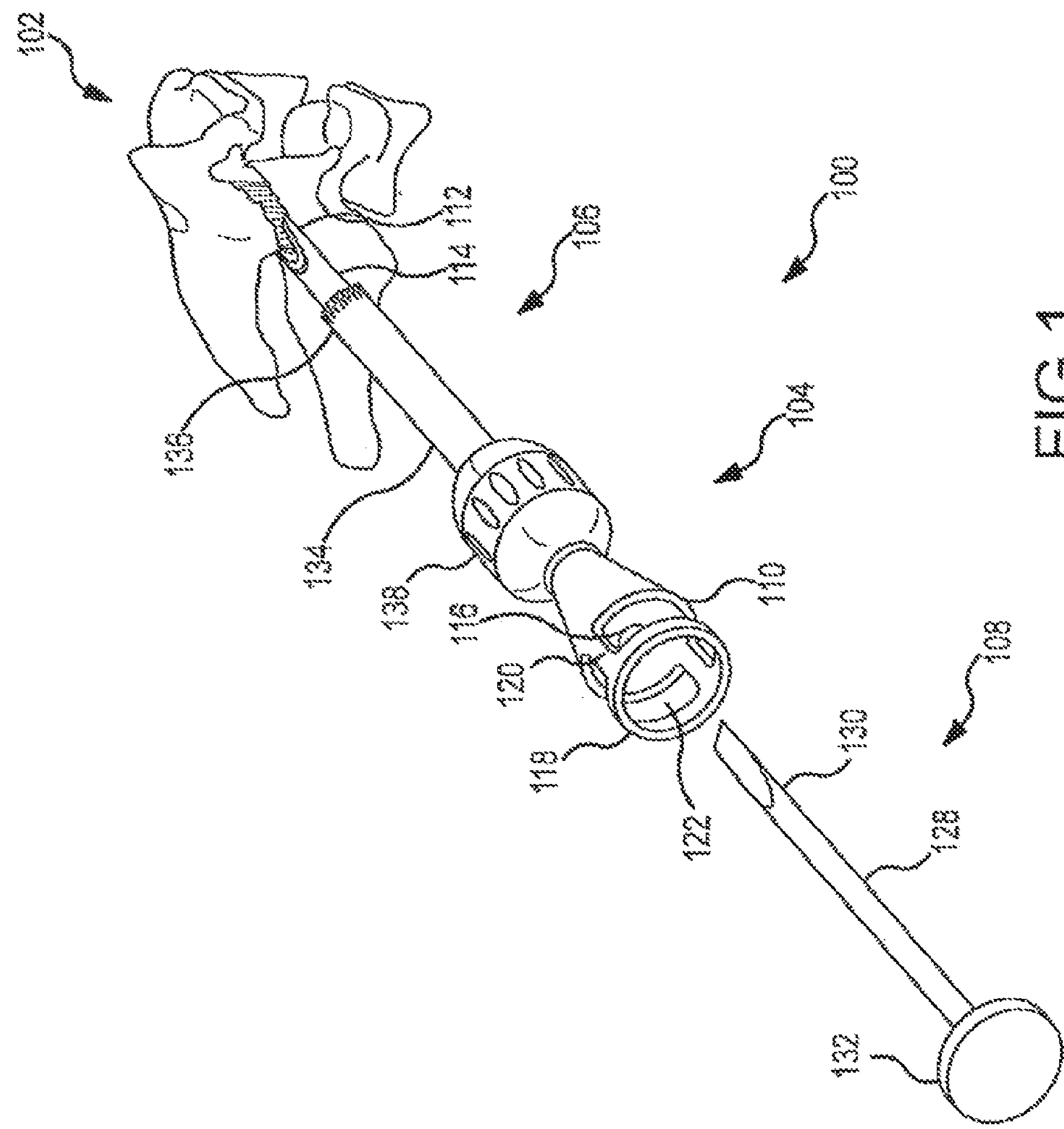
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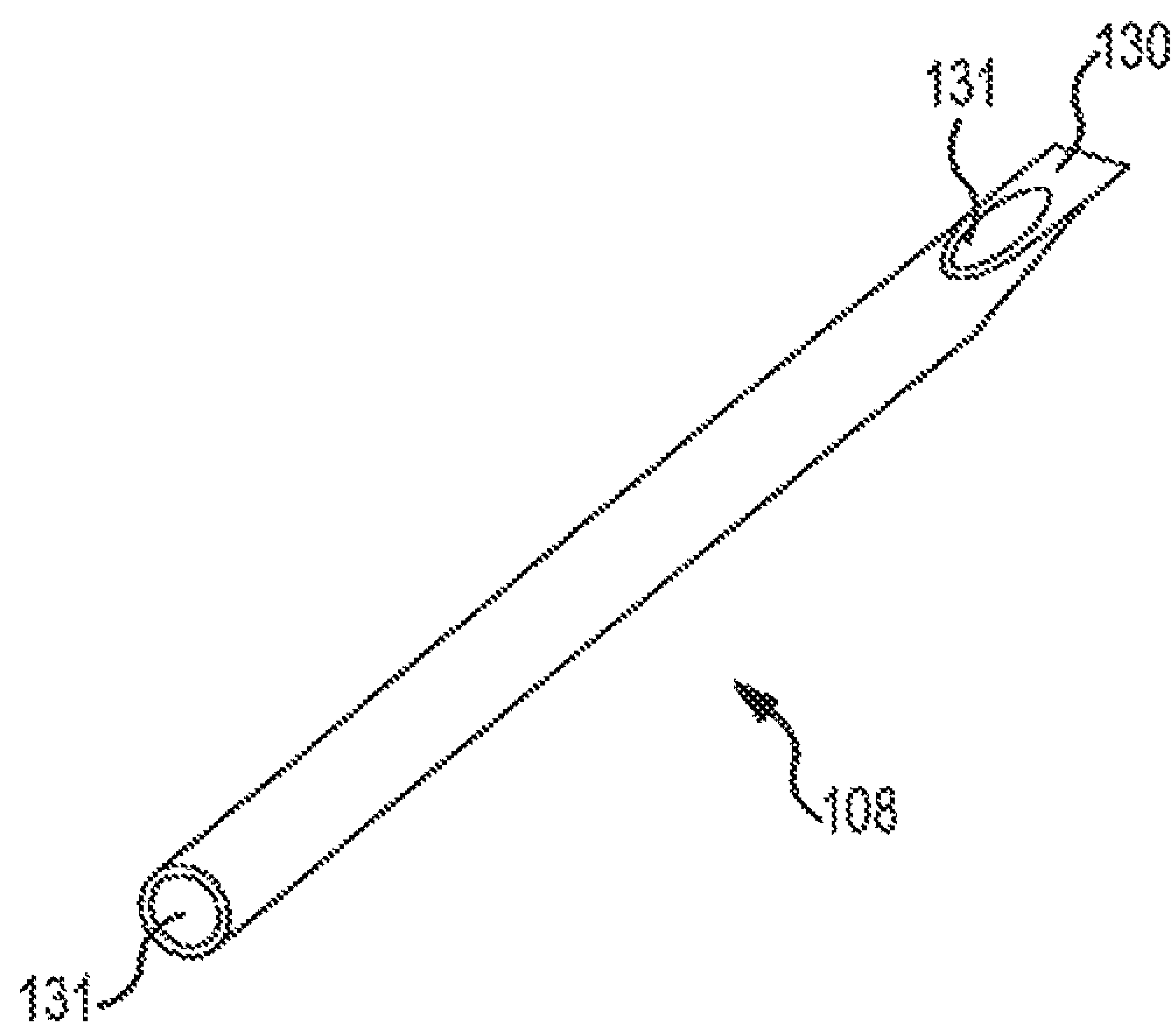
FIG. 1



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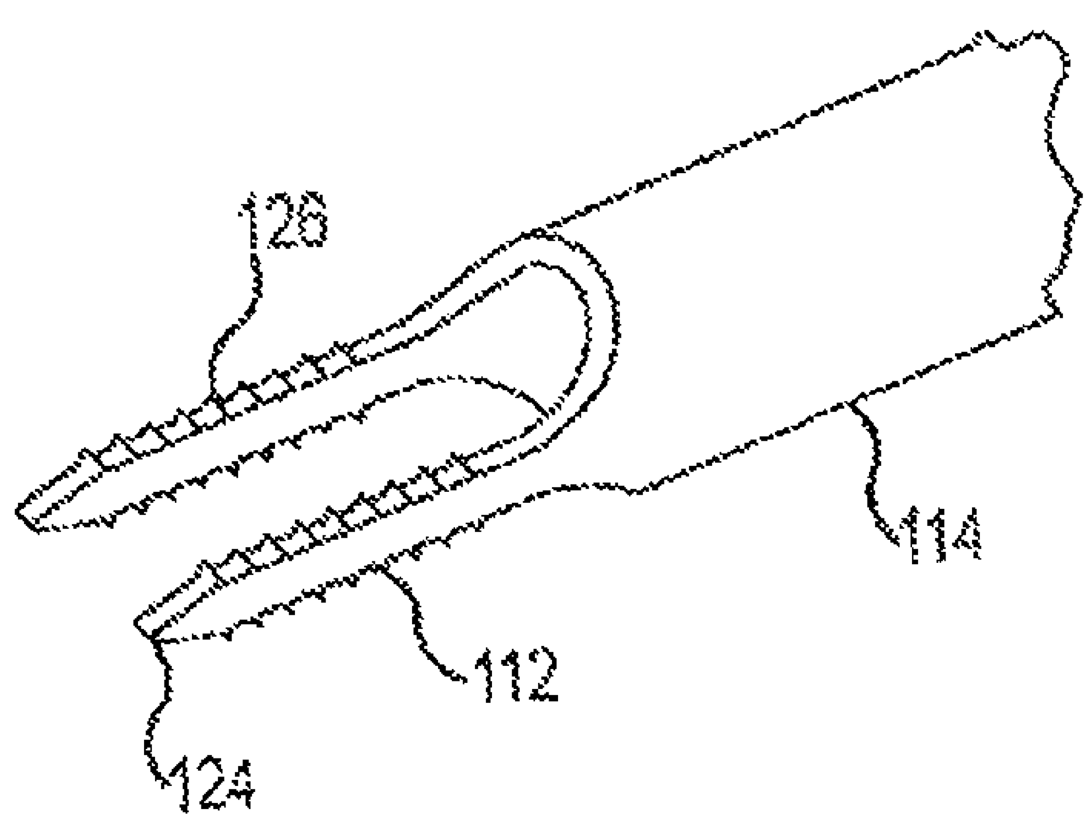


FIG.2

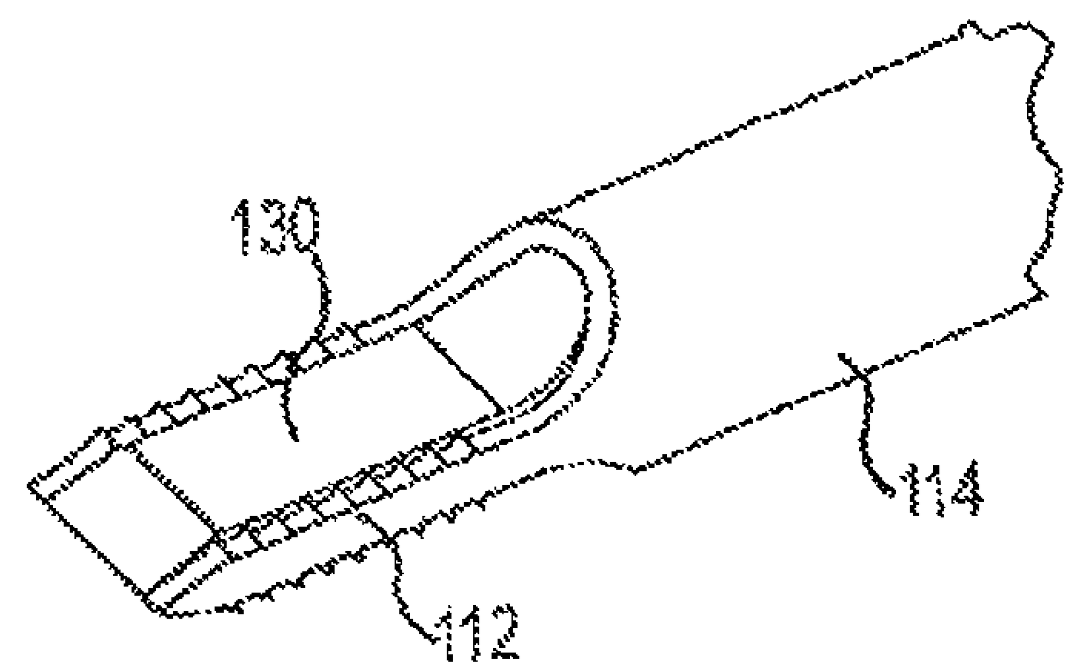


FIG.3

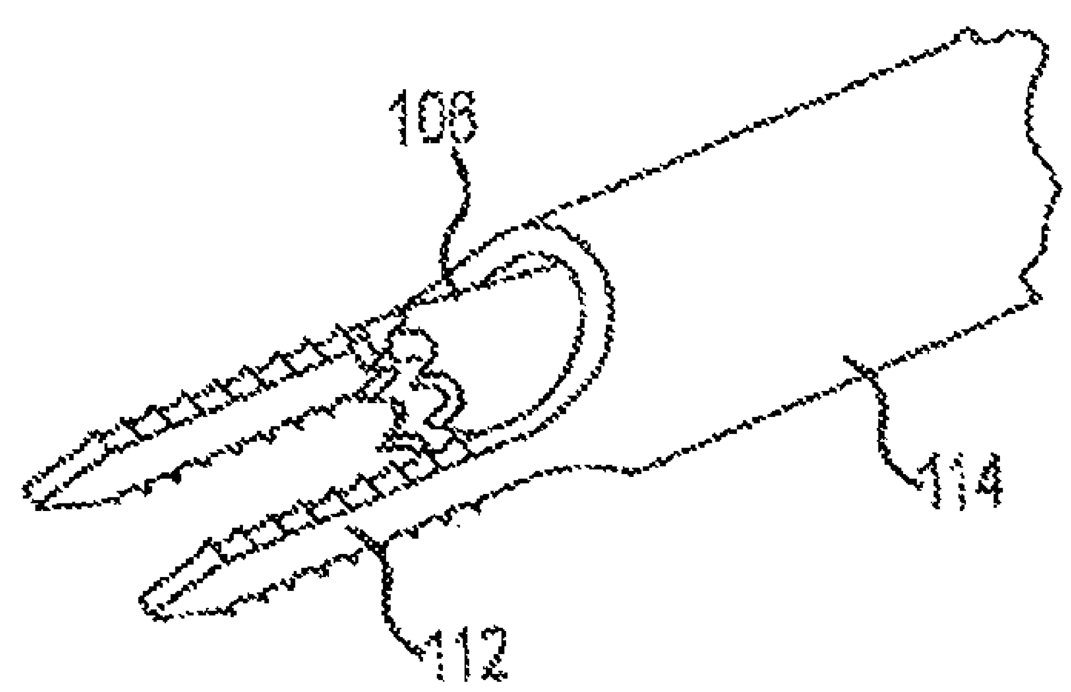


FIG.4

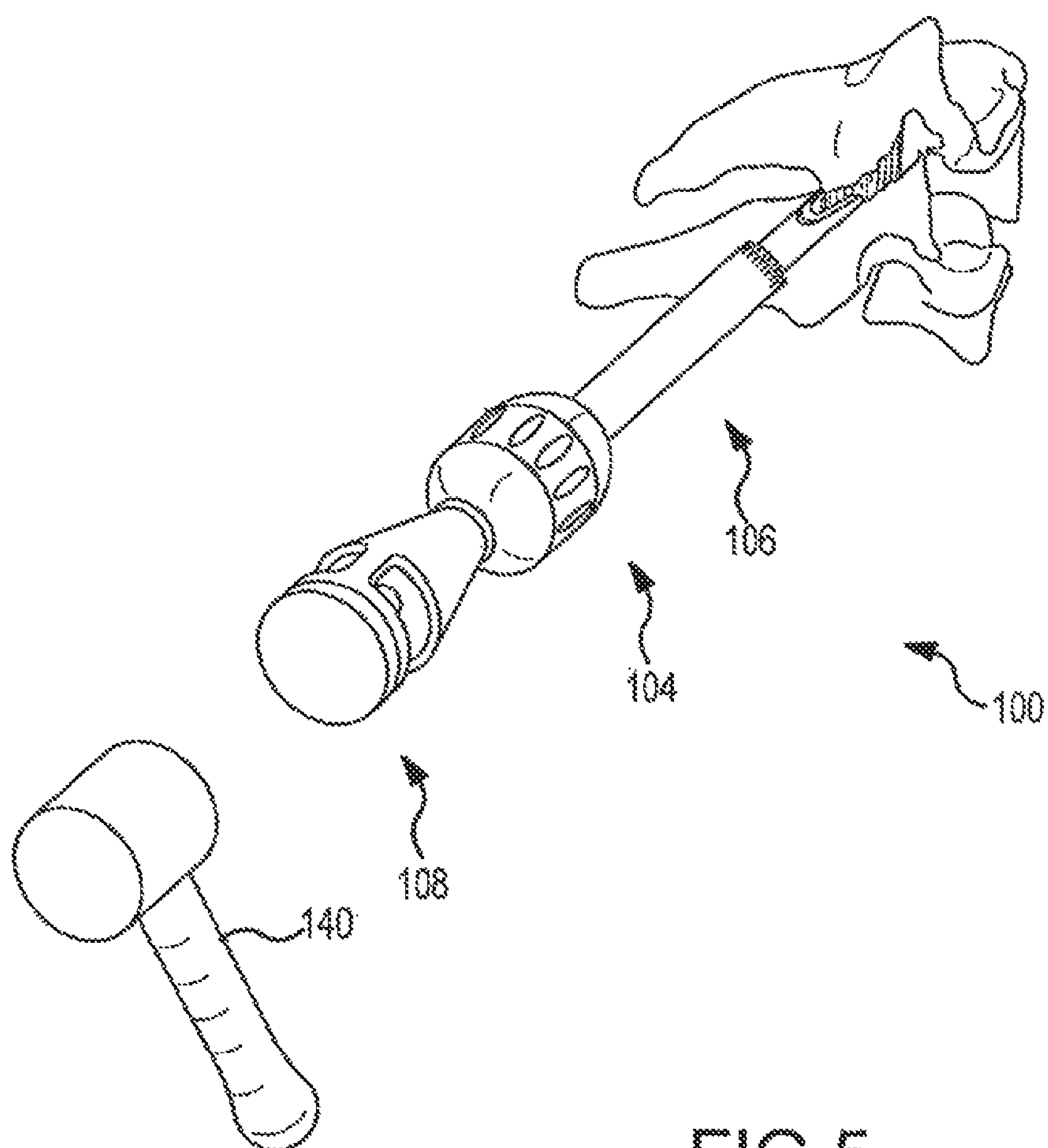


FIG.5

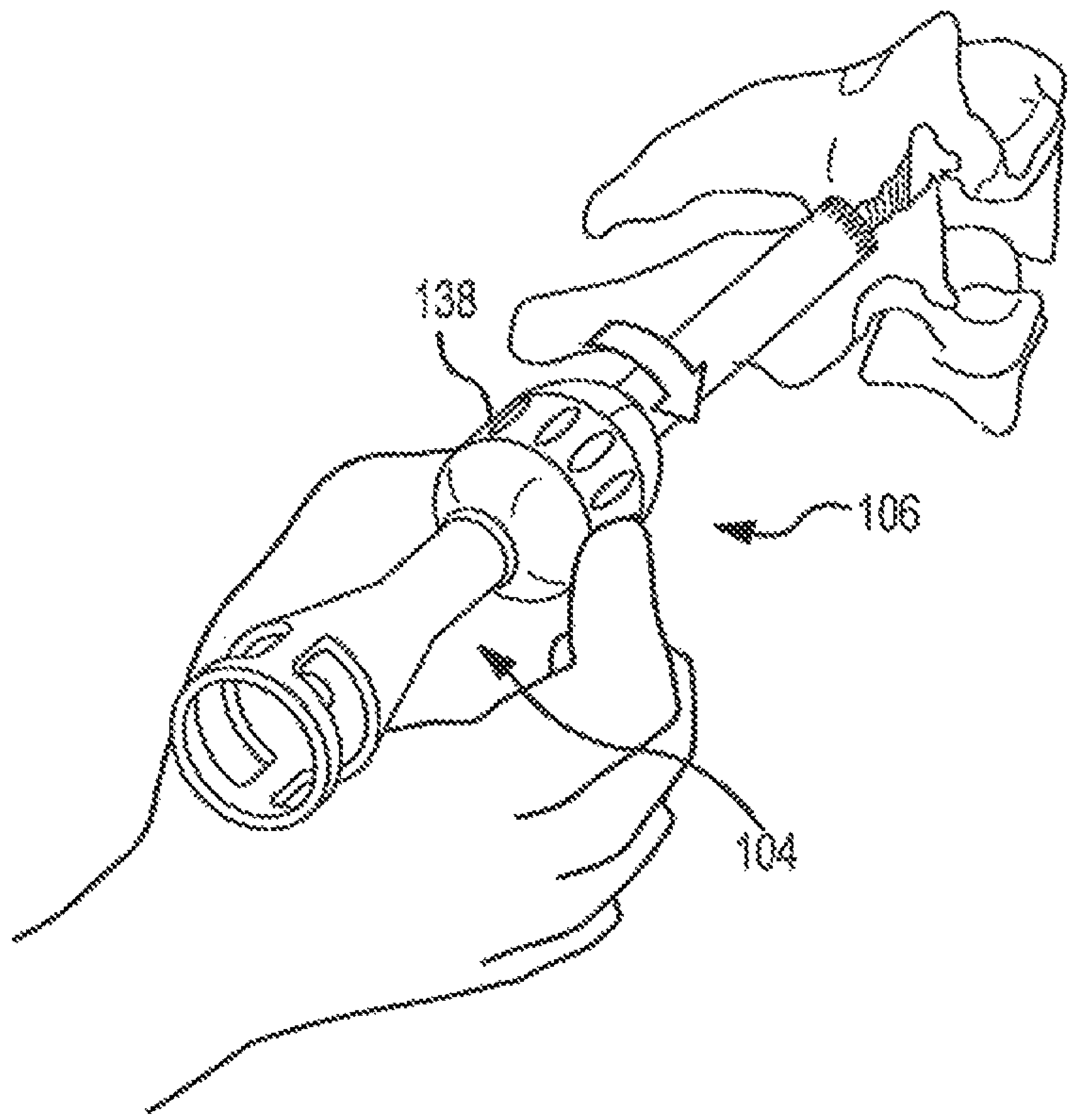


FIG.6

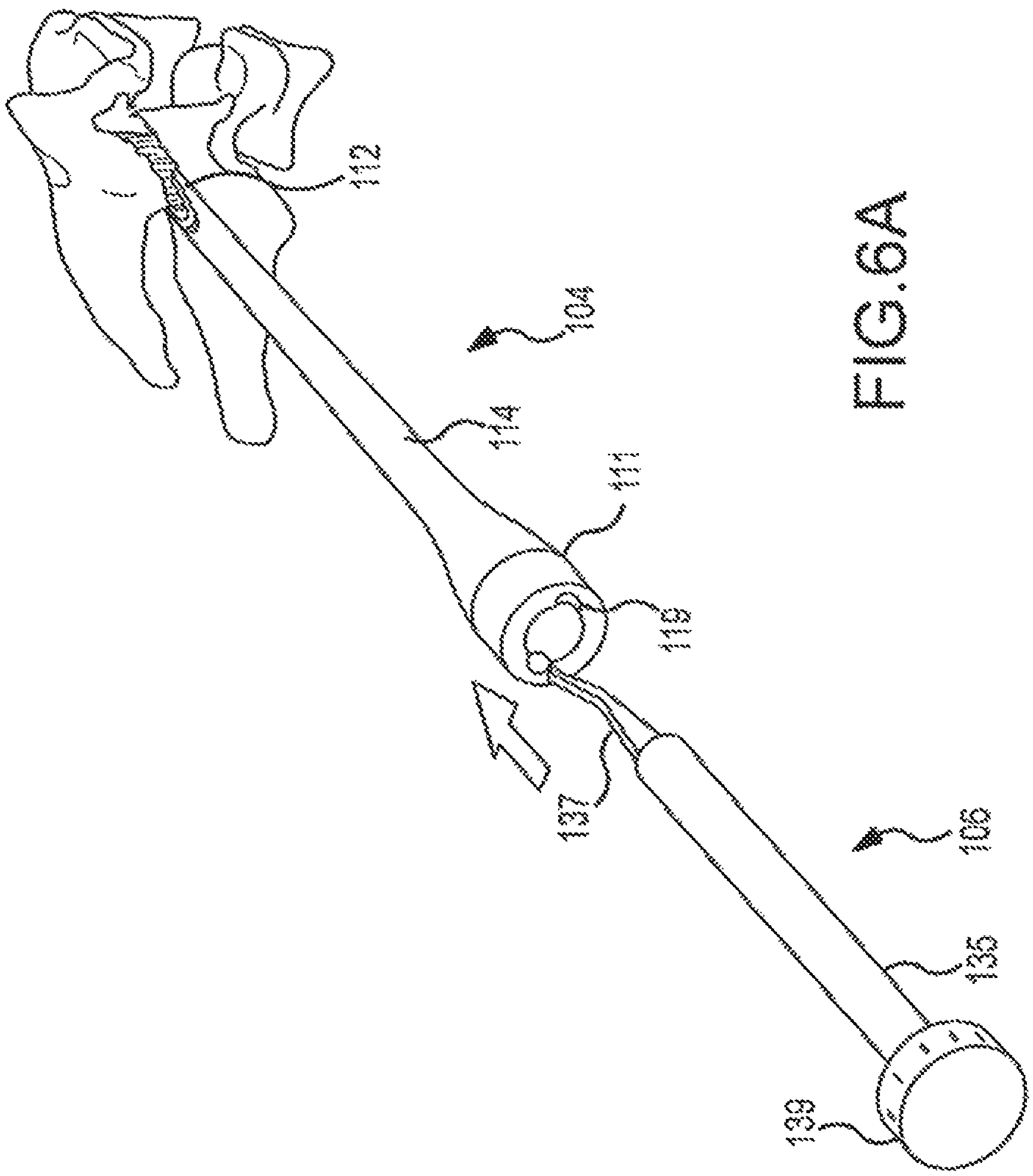


FIG.6A

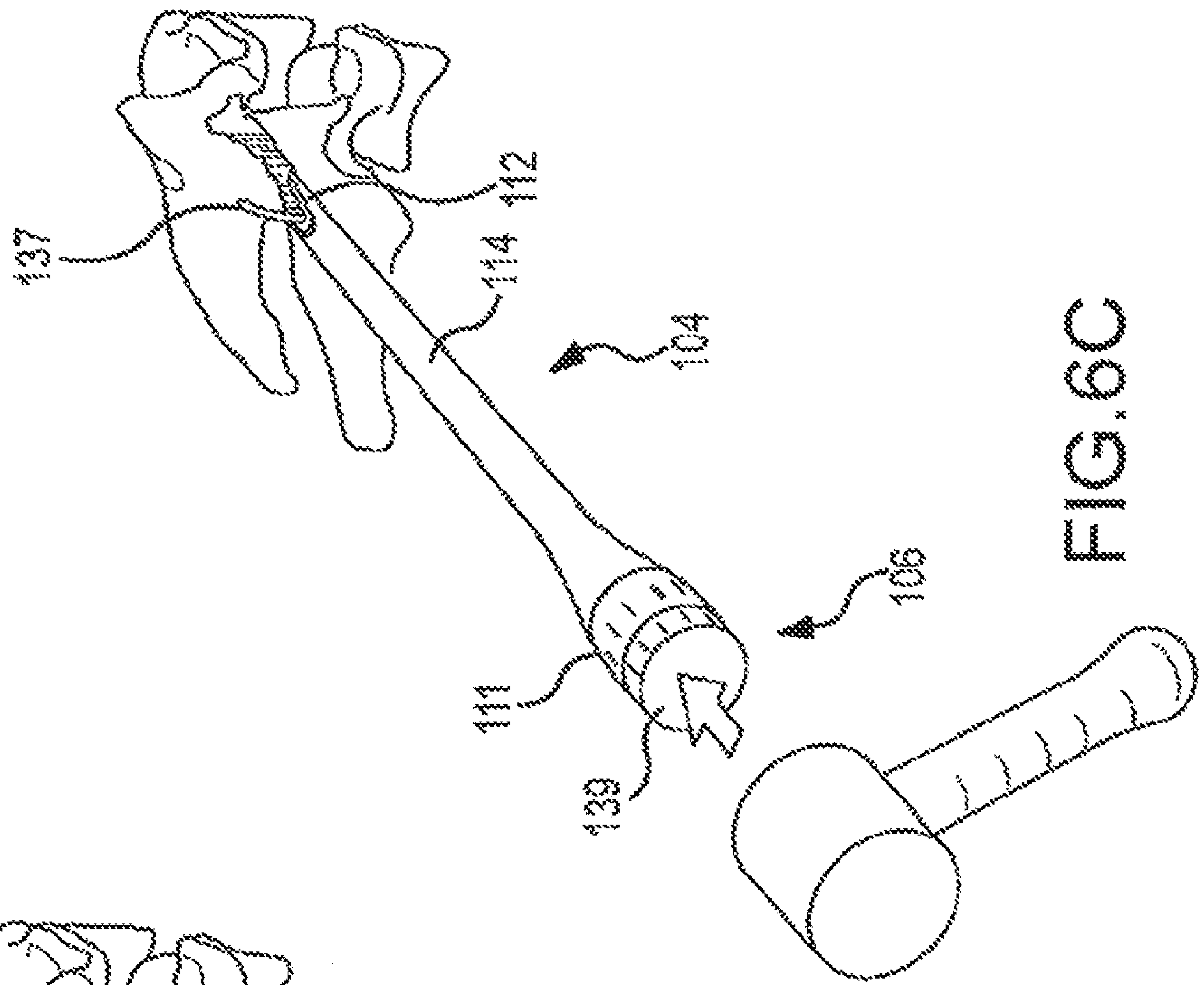


FIG. 6C

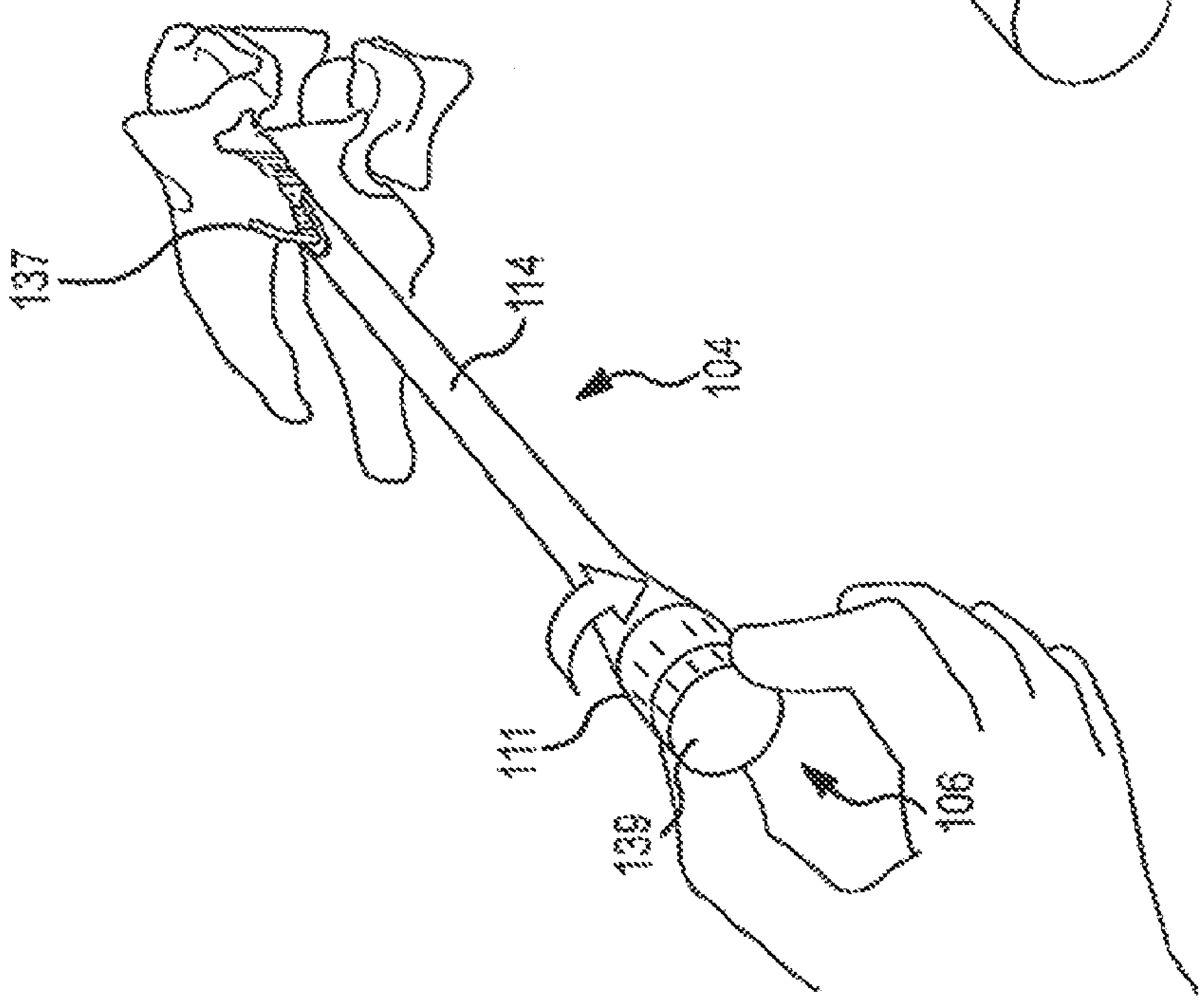


FIG. 6B

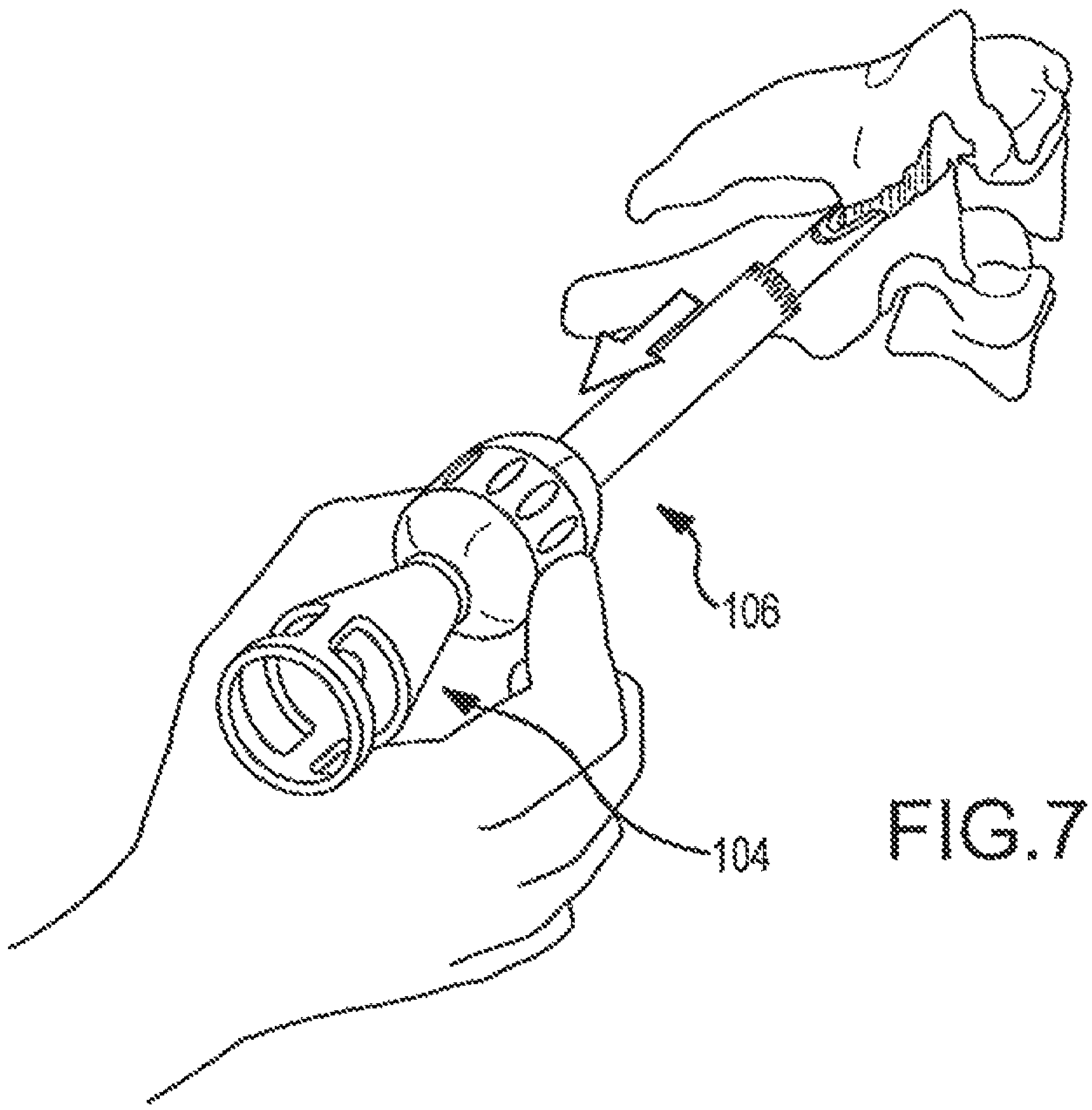


FIG.7

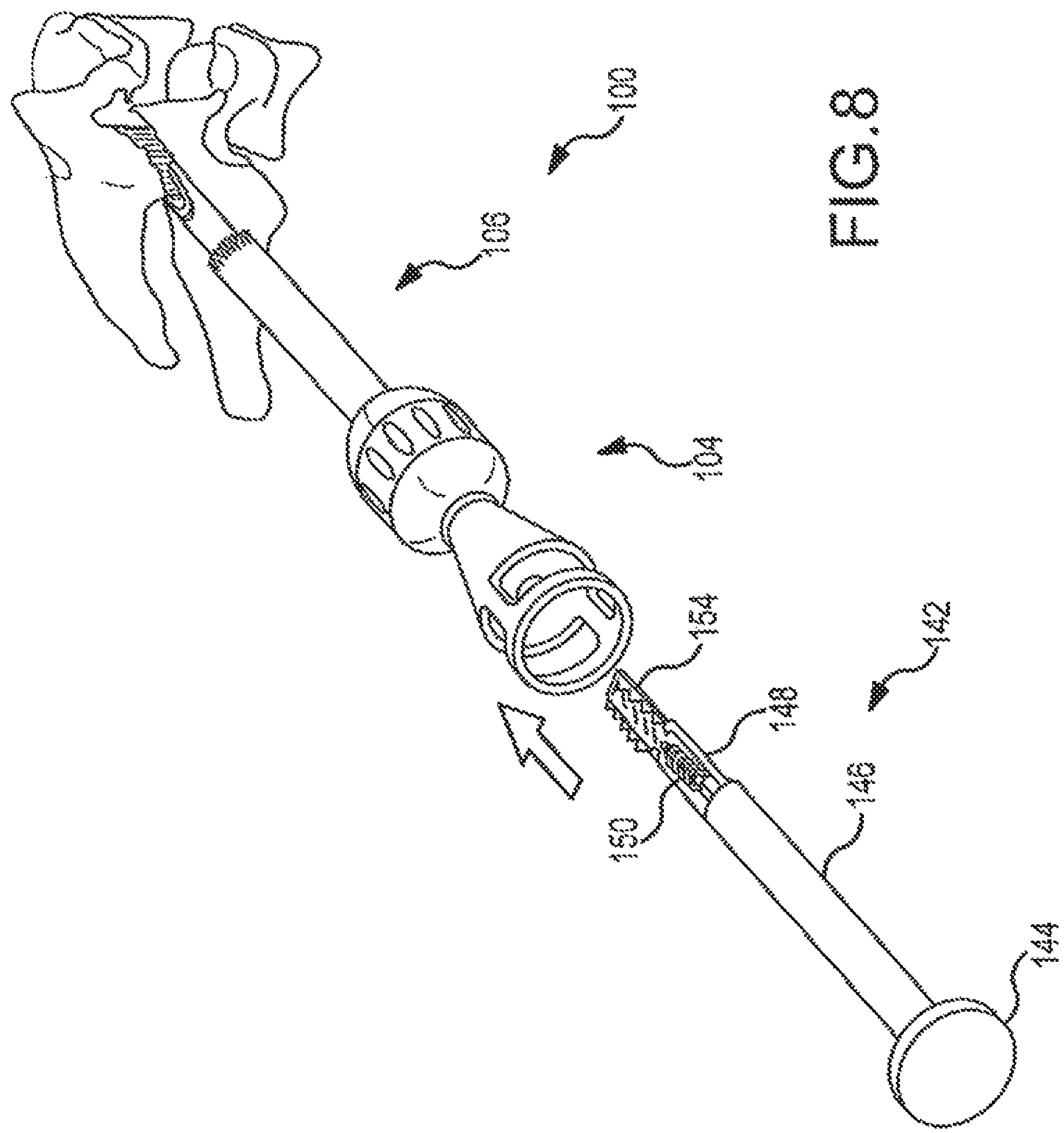


FIG.8

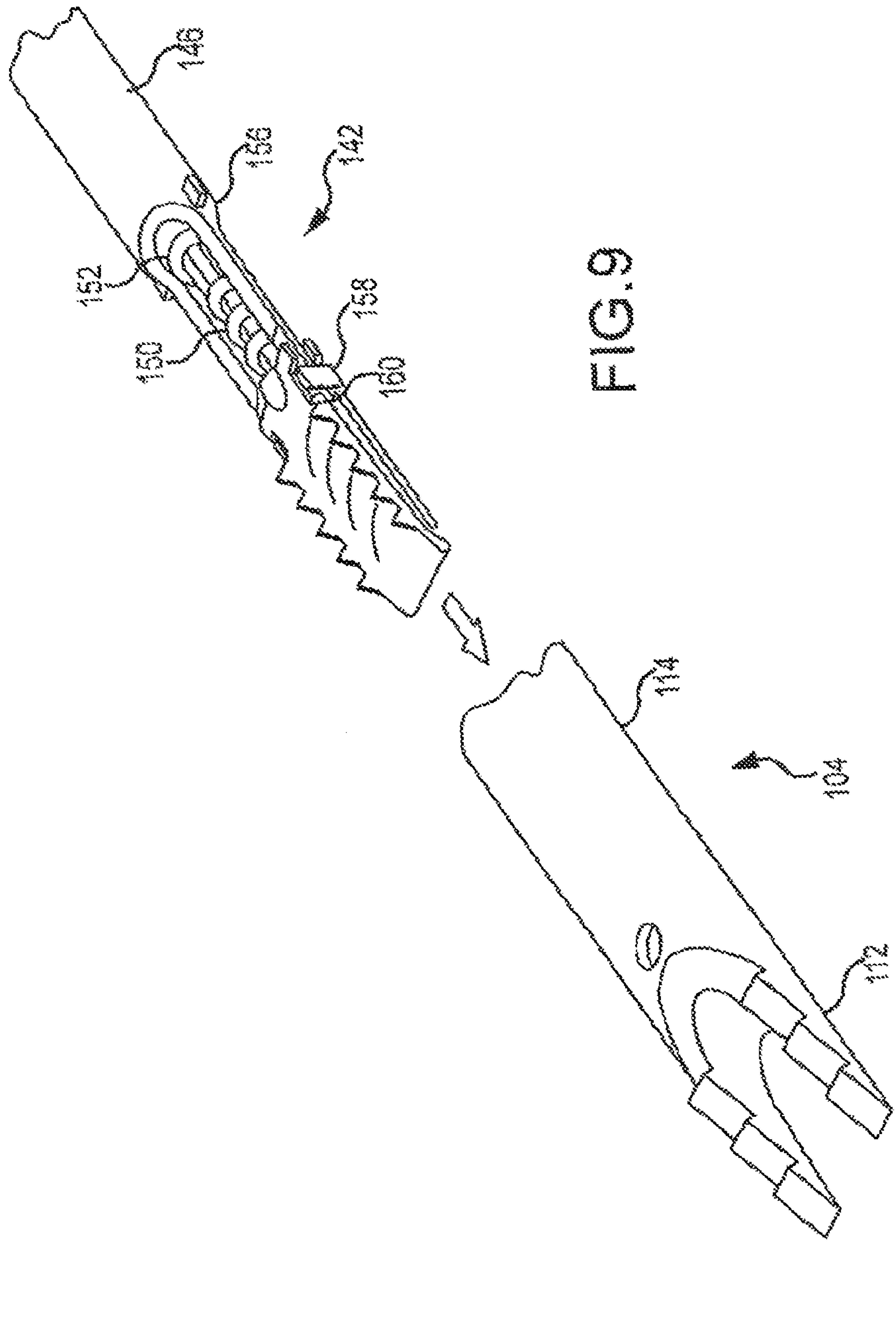


FIG.9

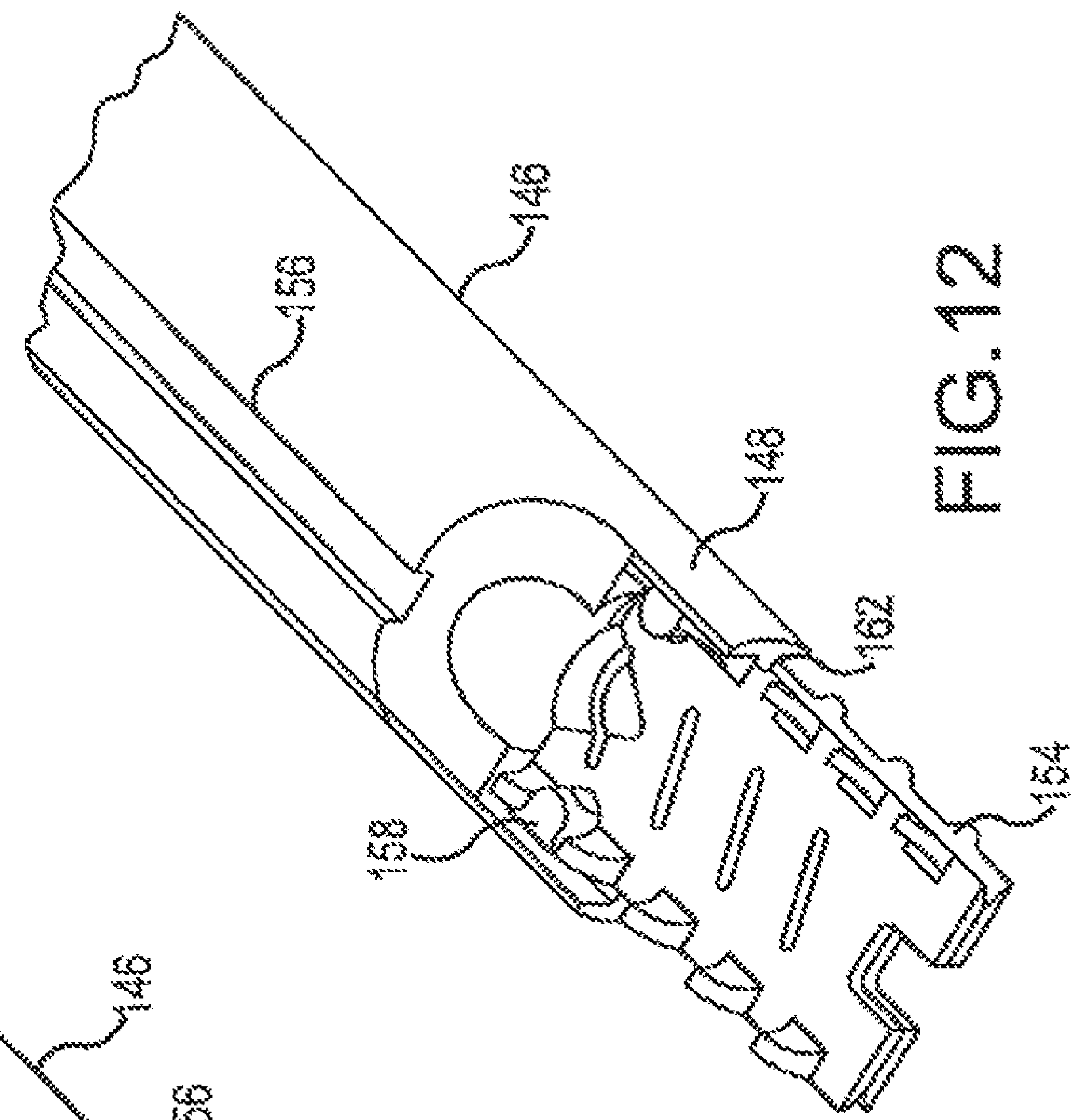


FIG. 12

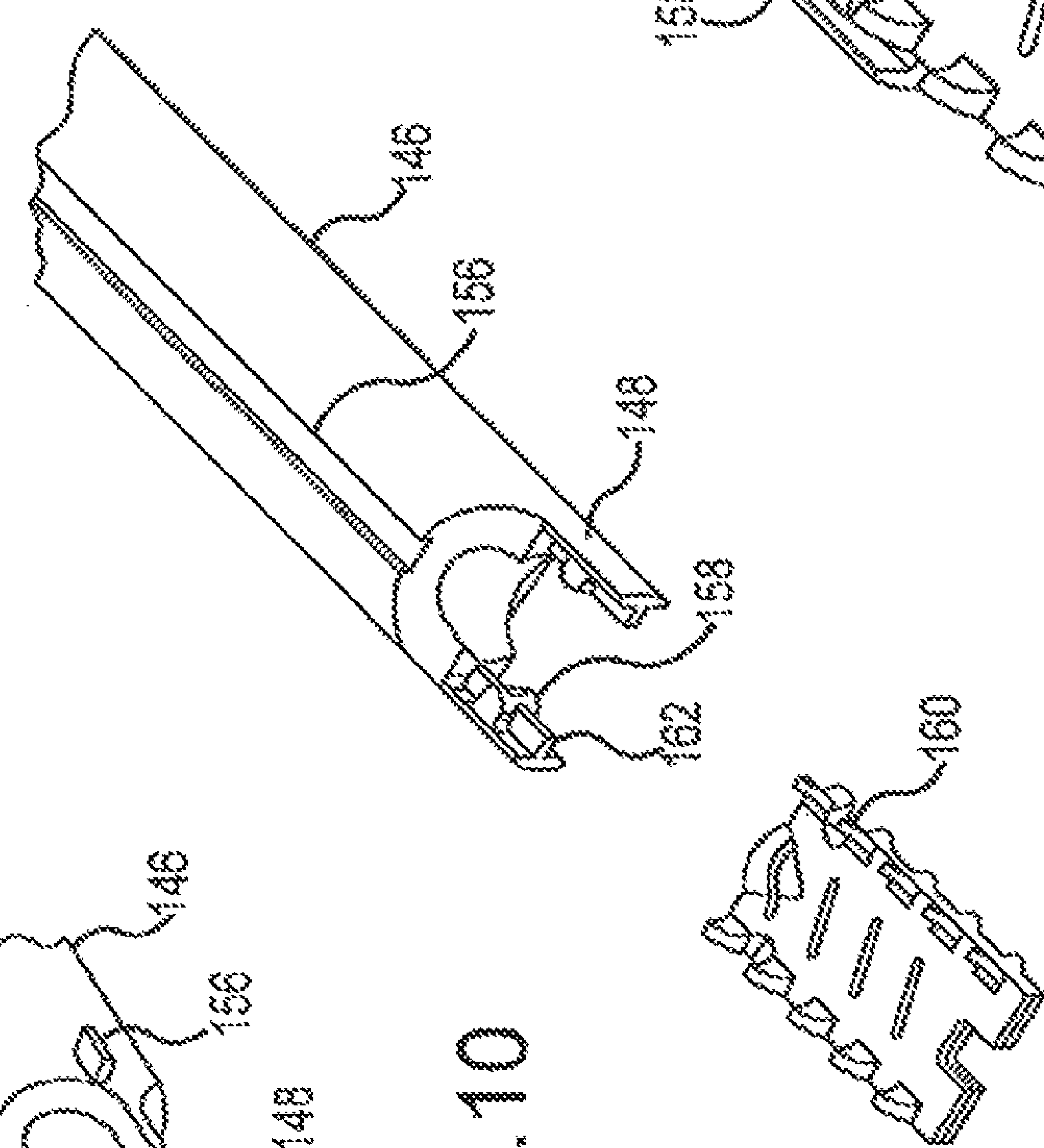


FIG. 11

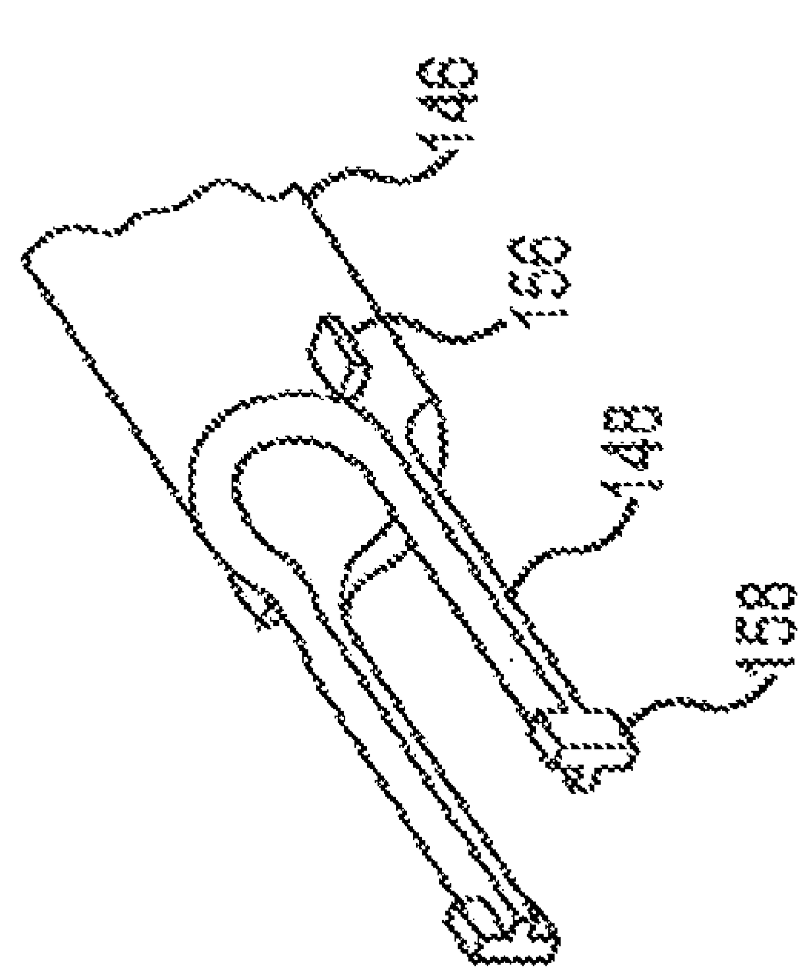


FIG. 10

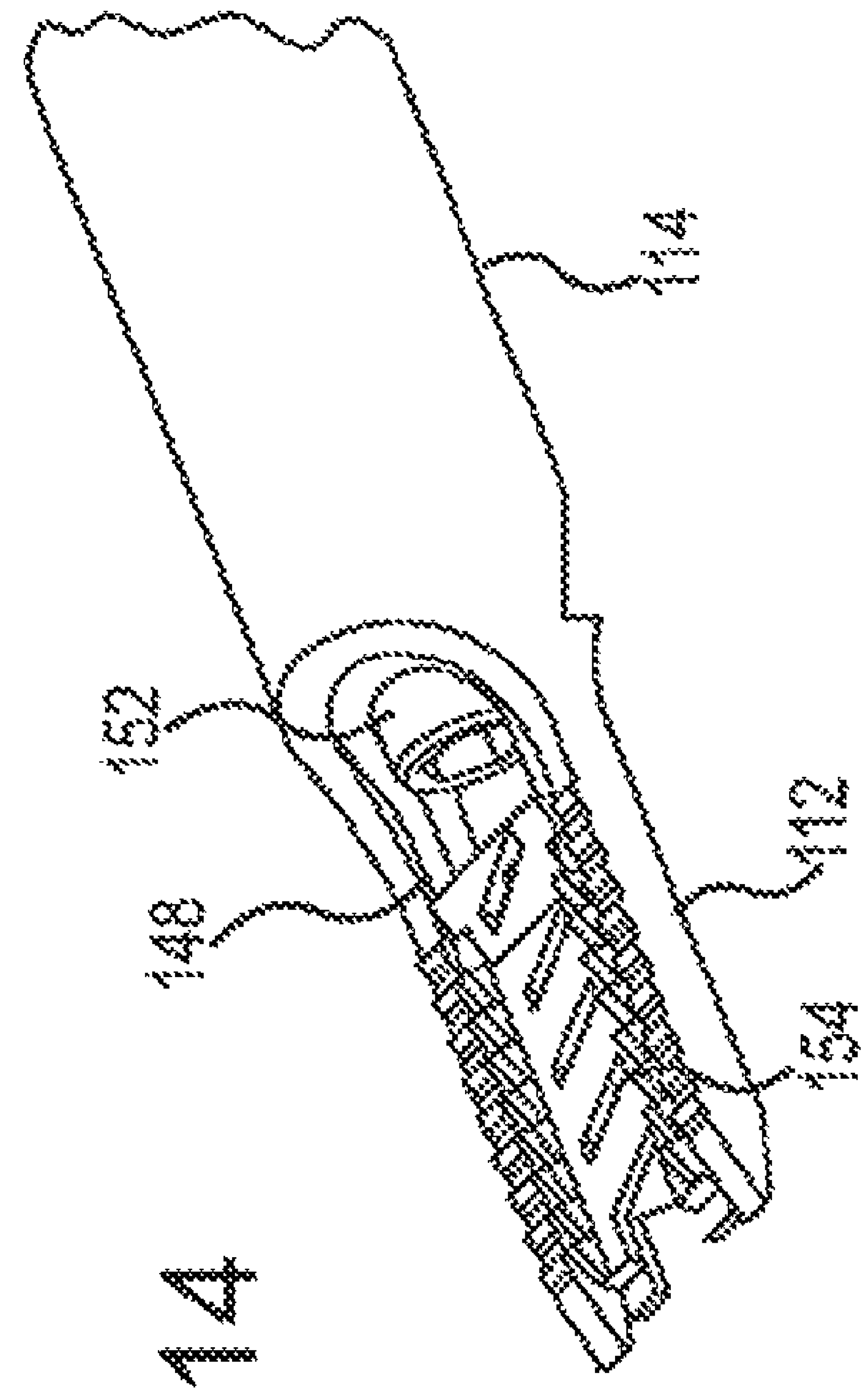


FIG. 15

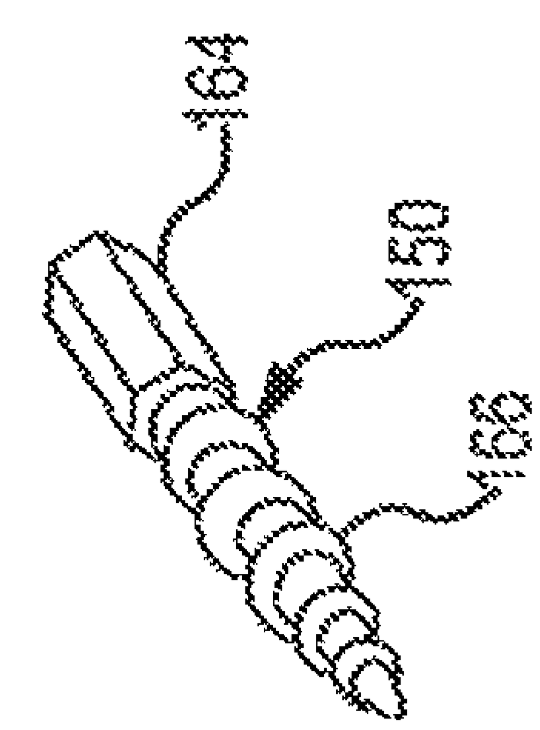


FIG. 14

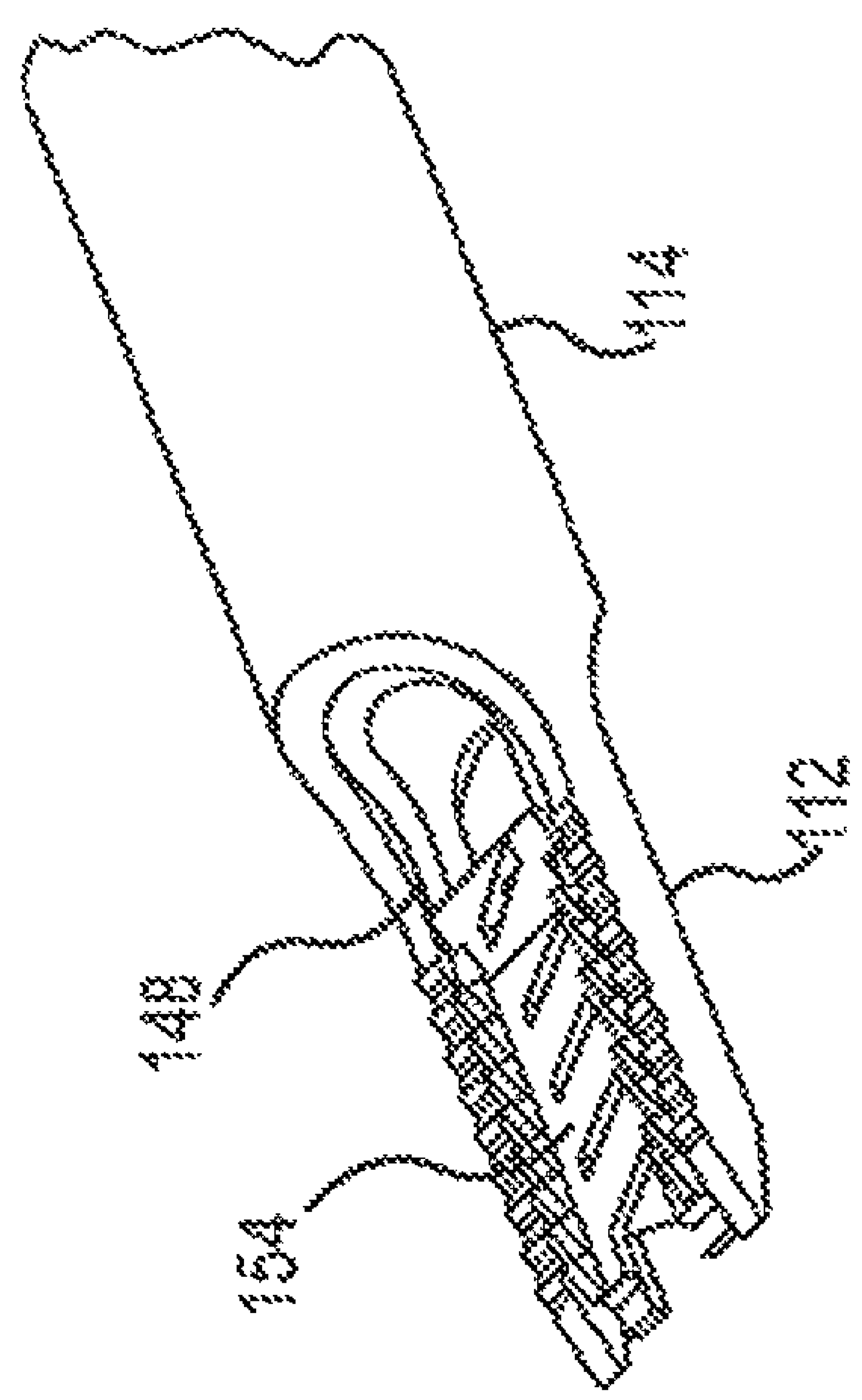


FIG. 13

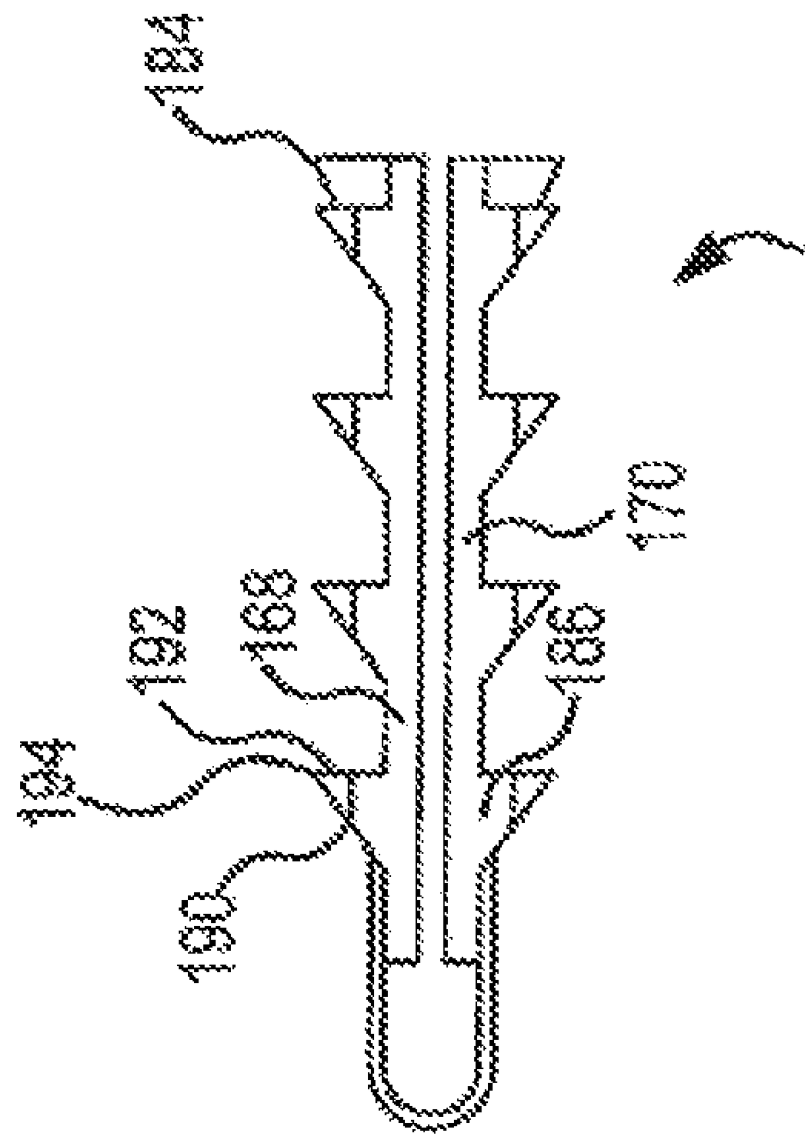


FIG. 17

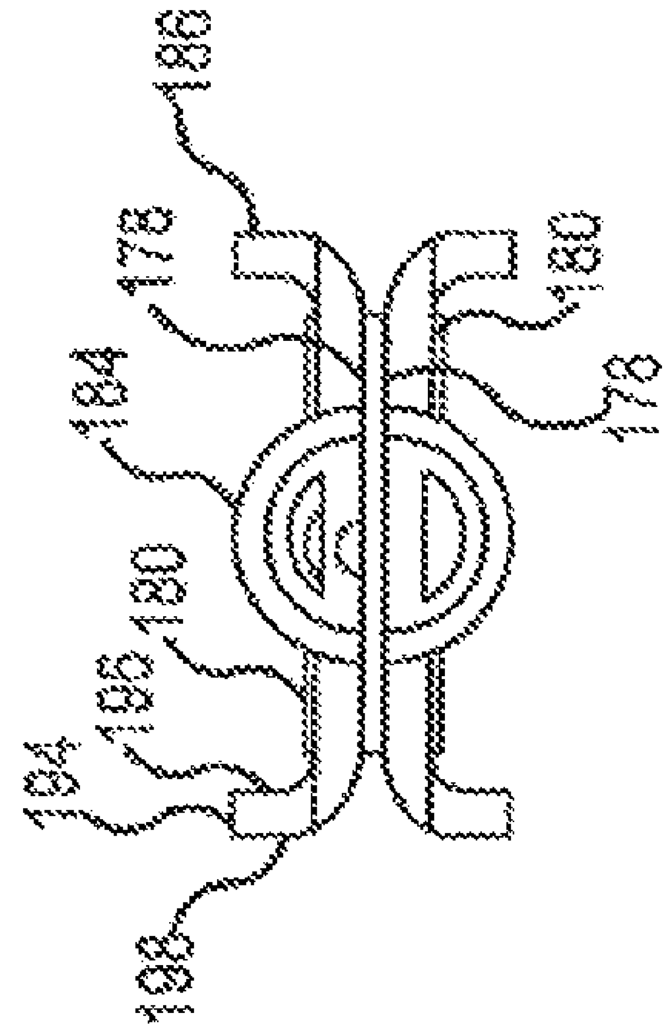


FIG. 19

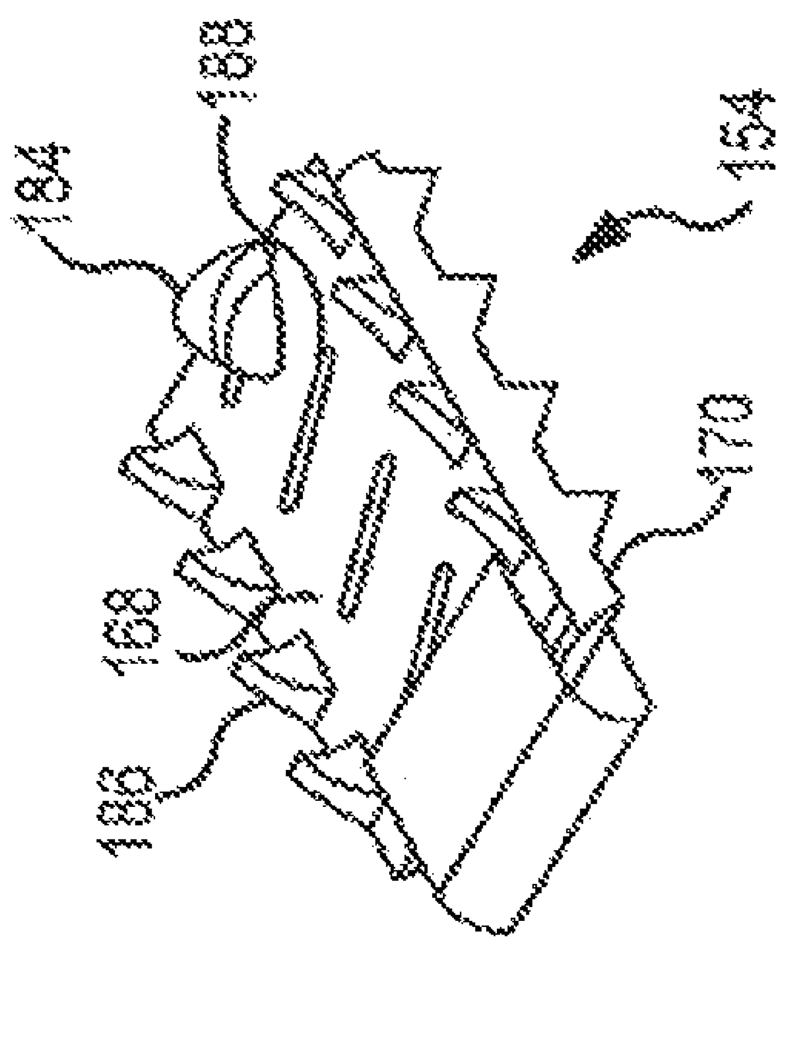


FIG. 16

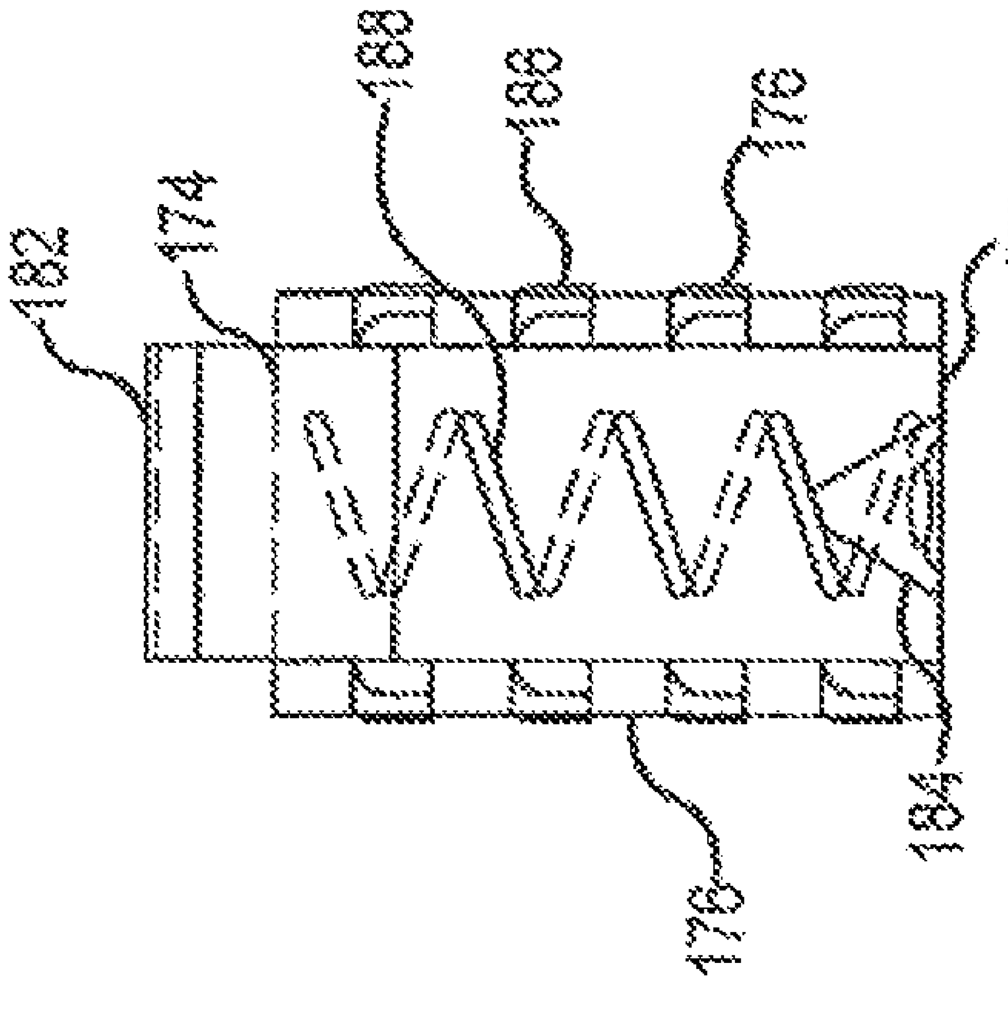


FIG. 18

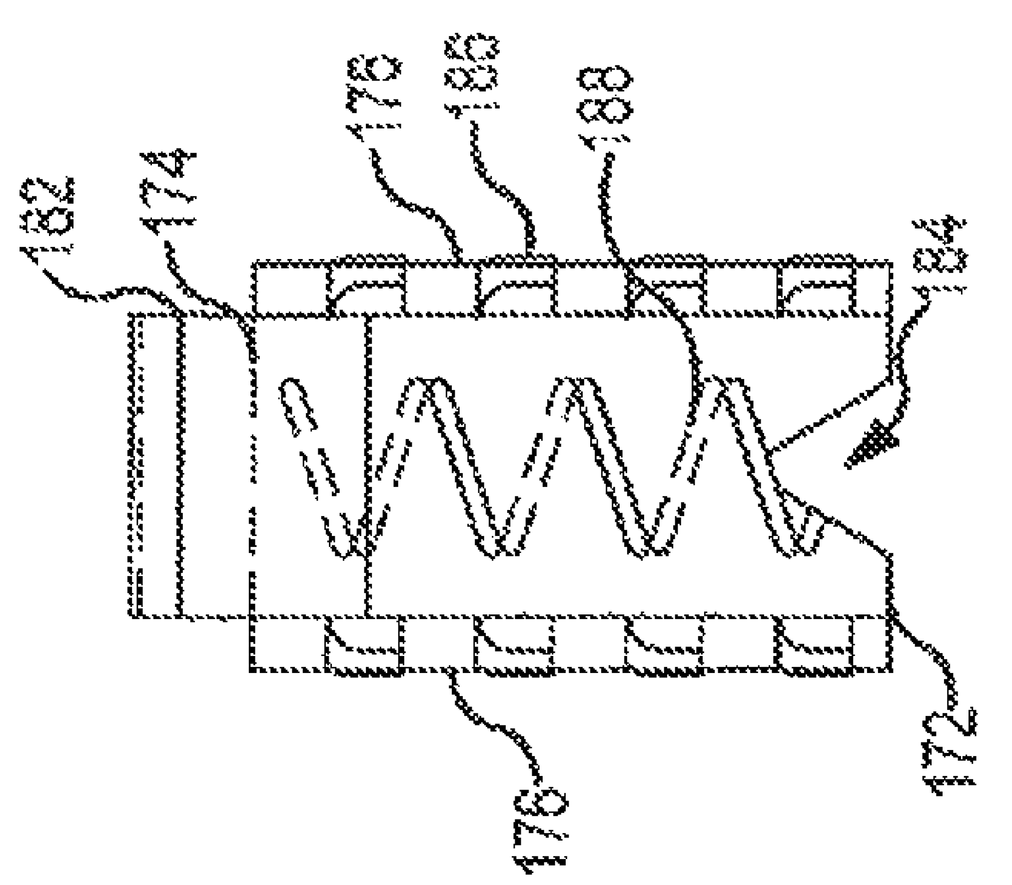


FIG. 18A

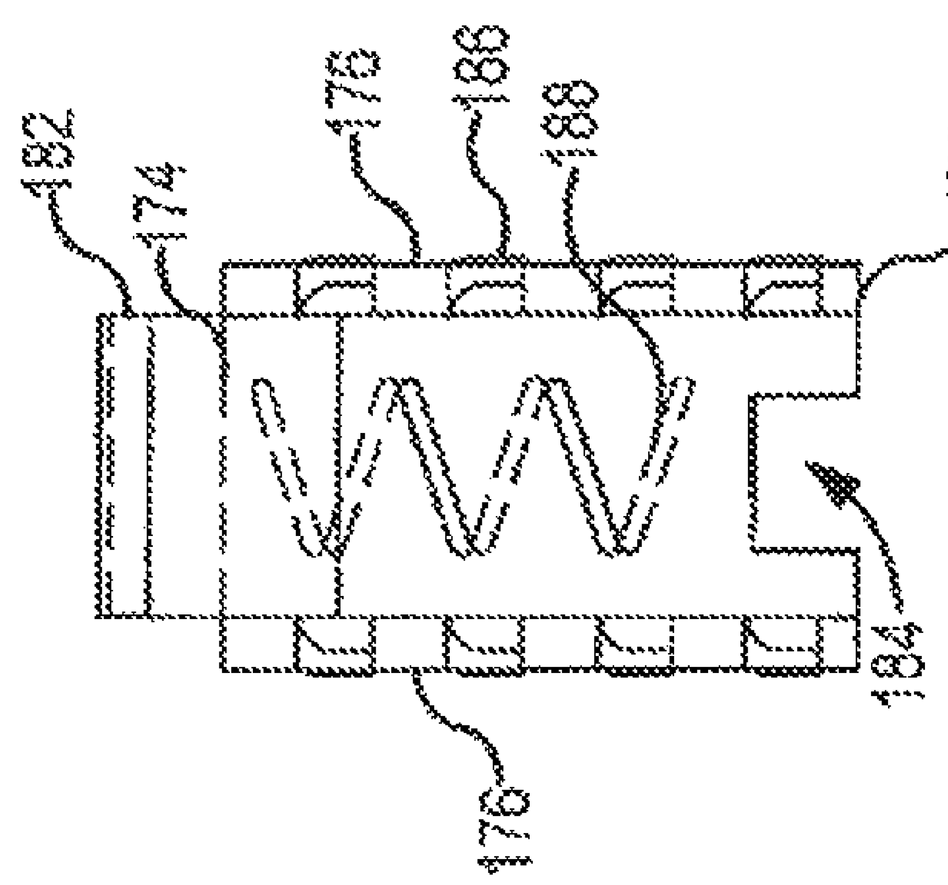


FIG. 18B

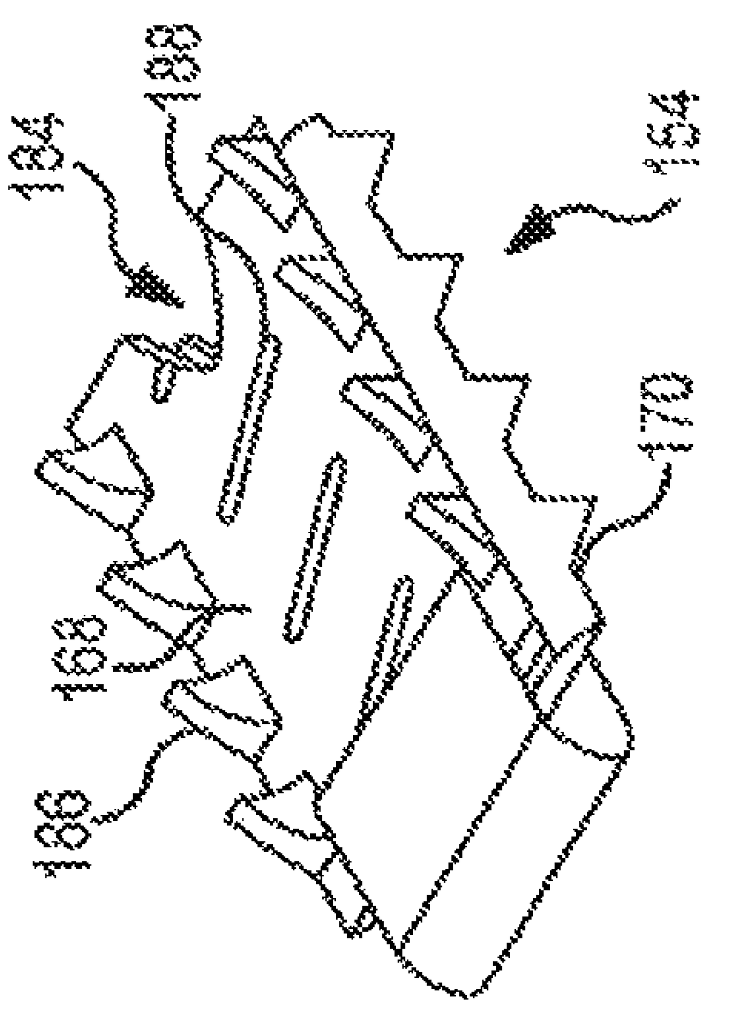


FIG. 16A

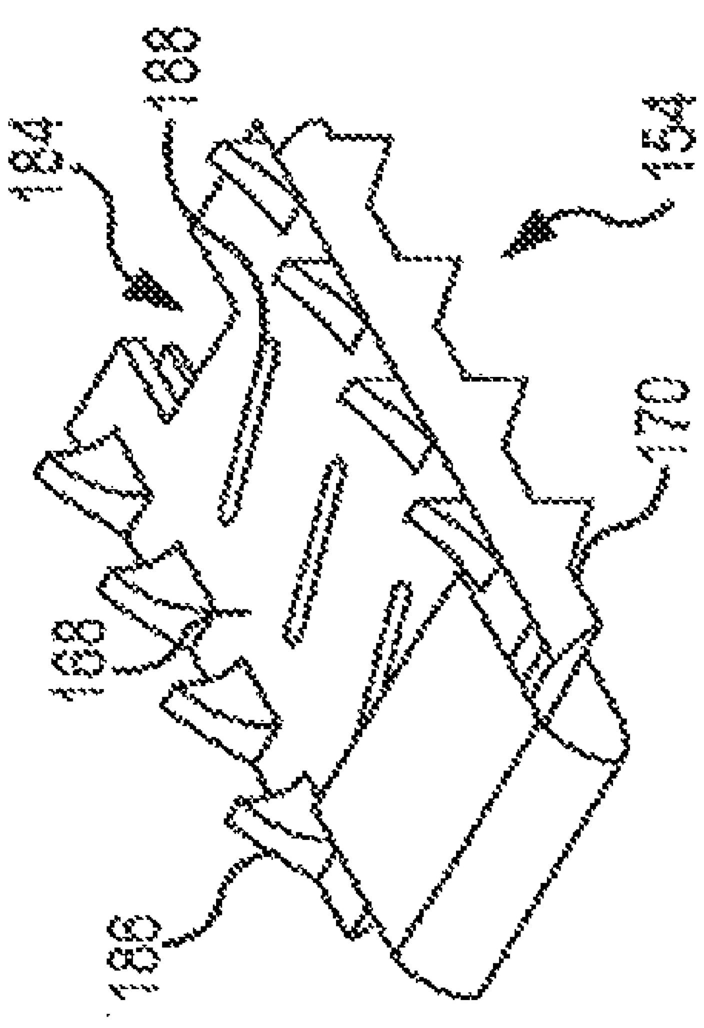


FIG. 16B

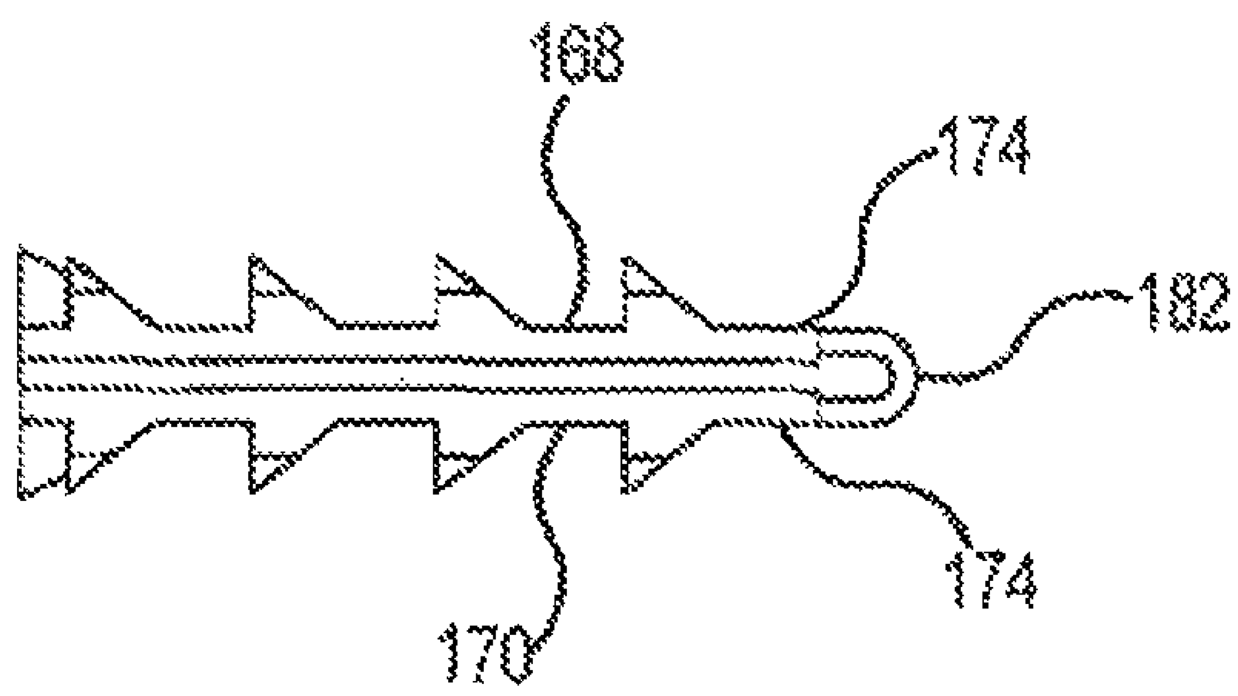


FIG.20

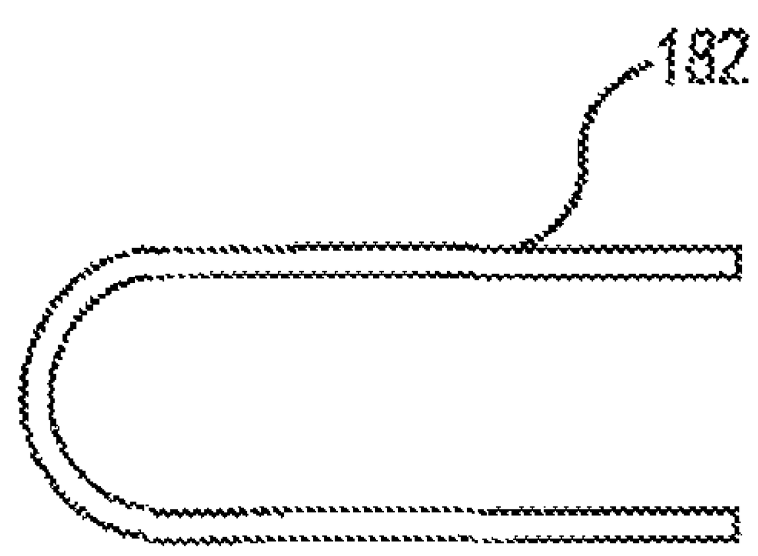
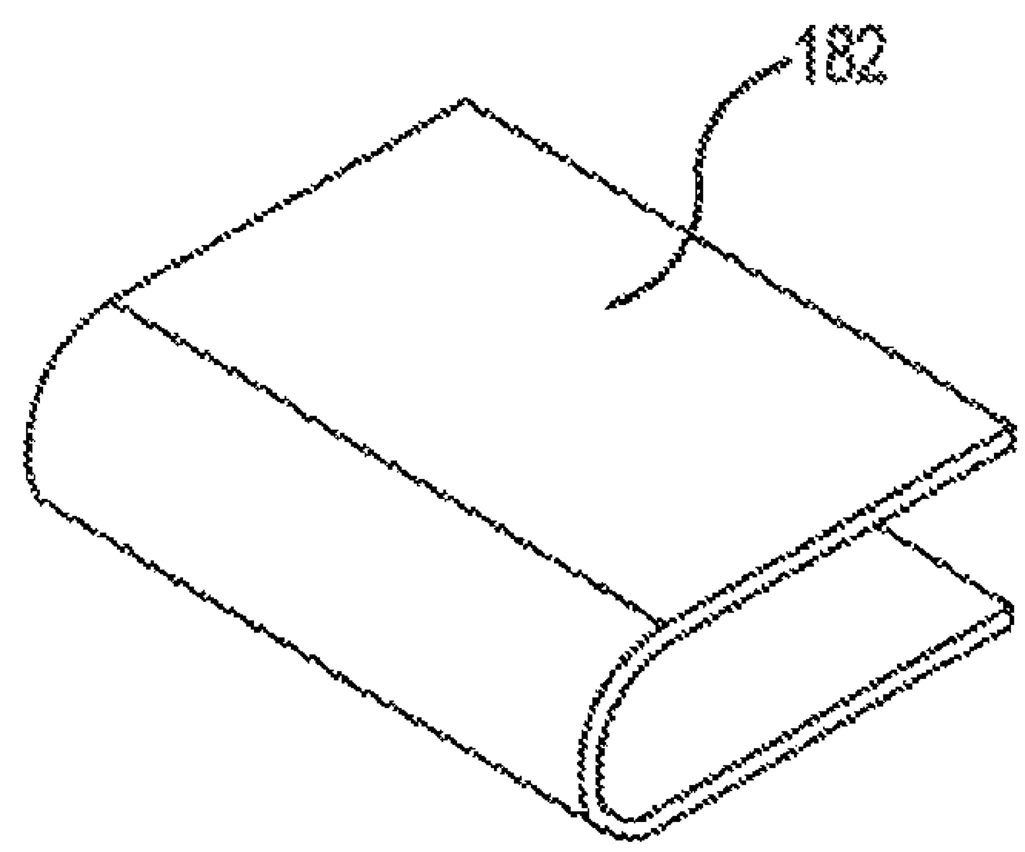


FIG.21



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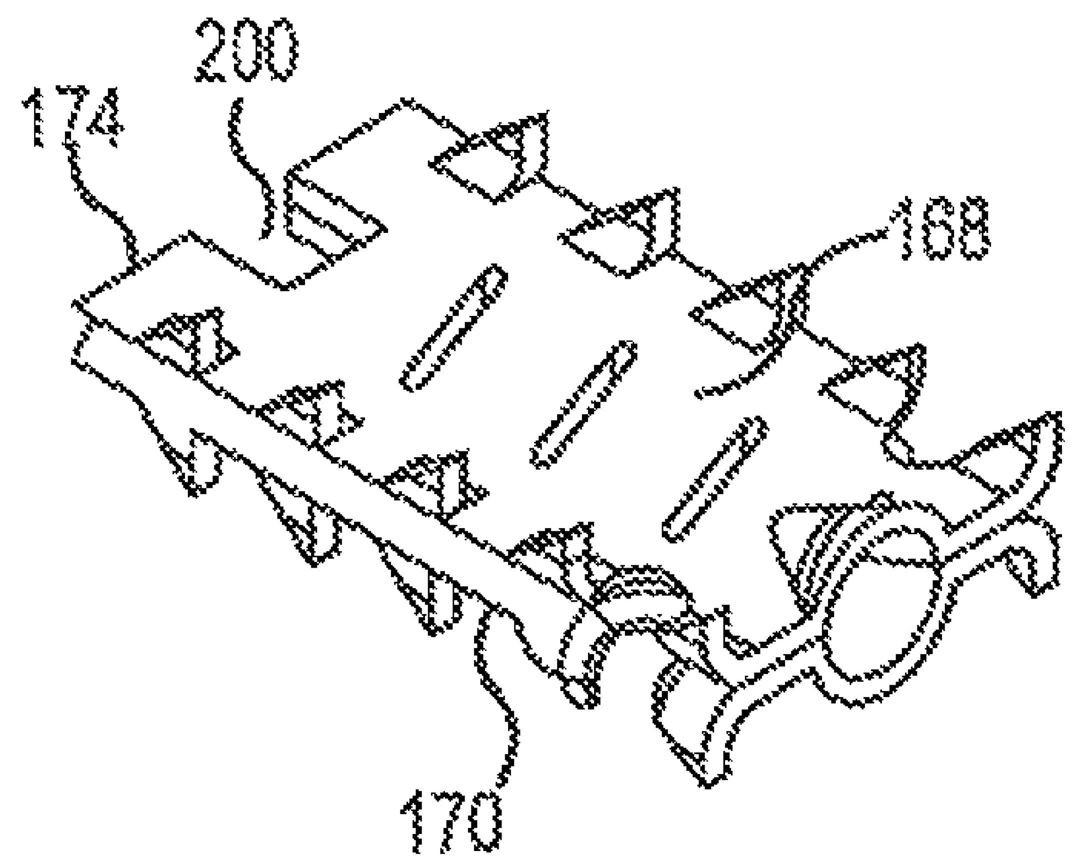


FIG.23

FIG.24

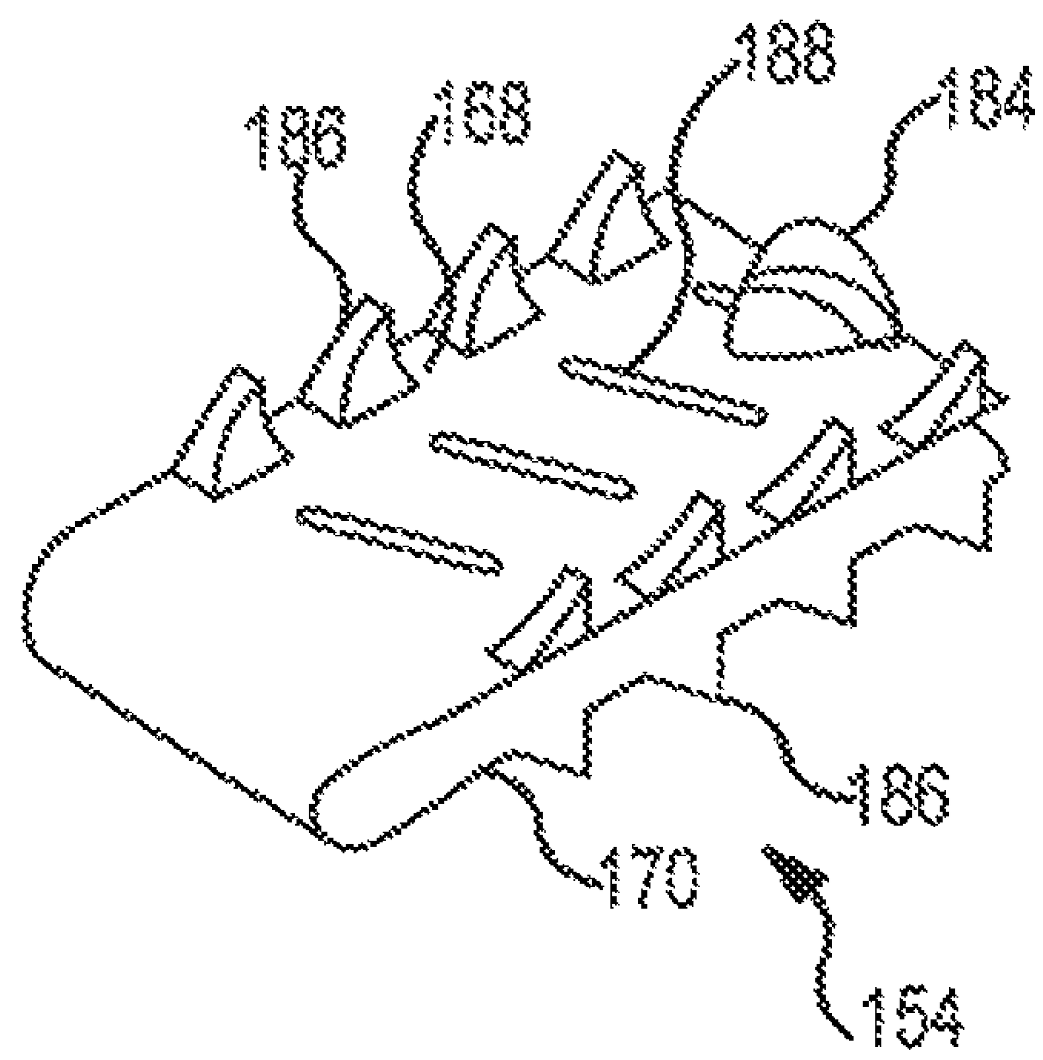


FIG.23A

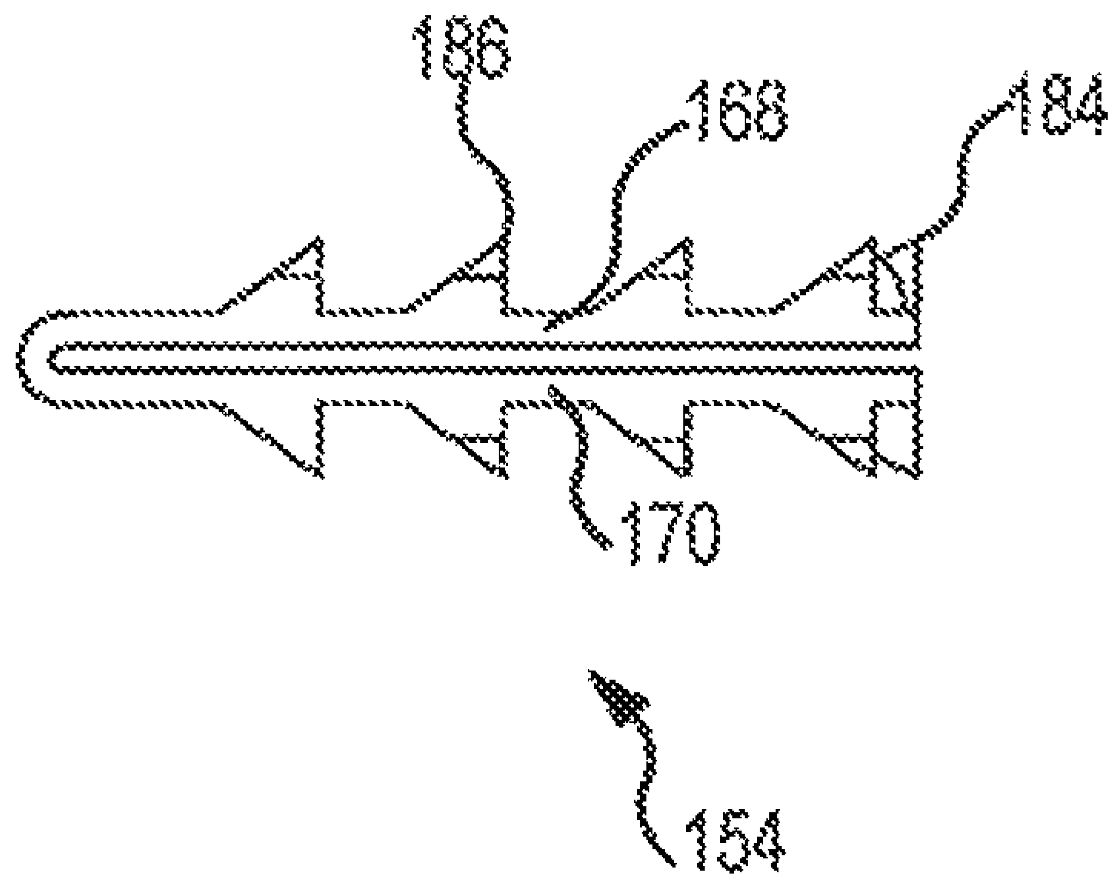


FIG.24A

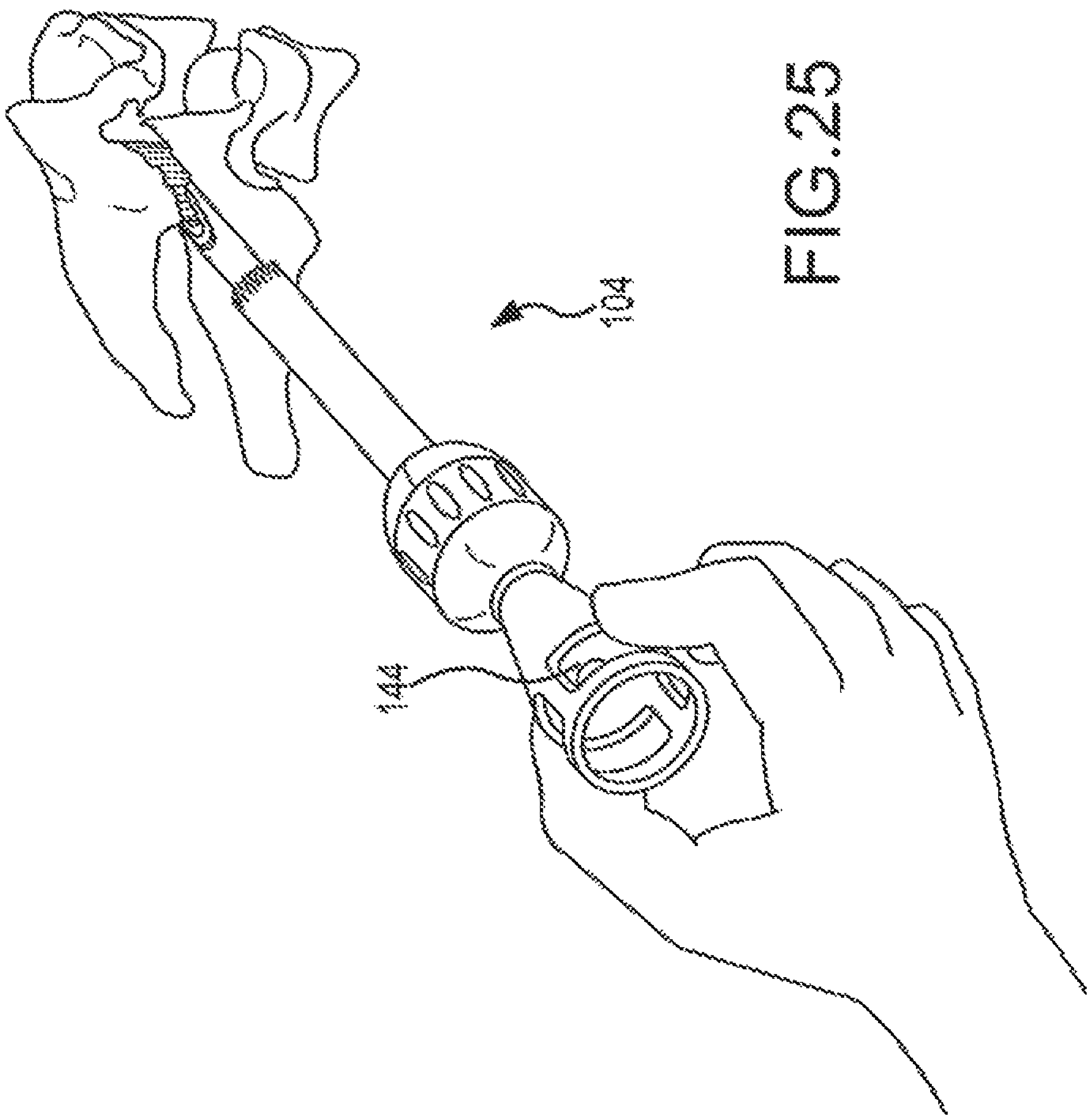


FIG.25

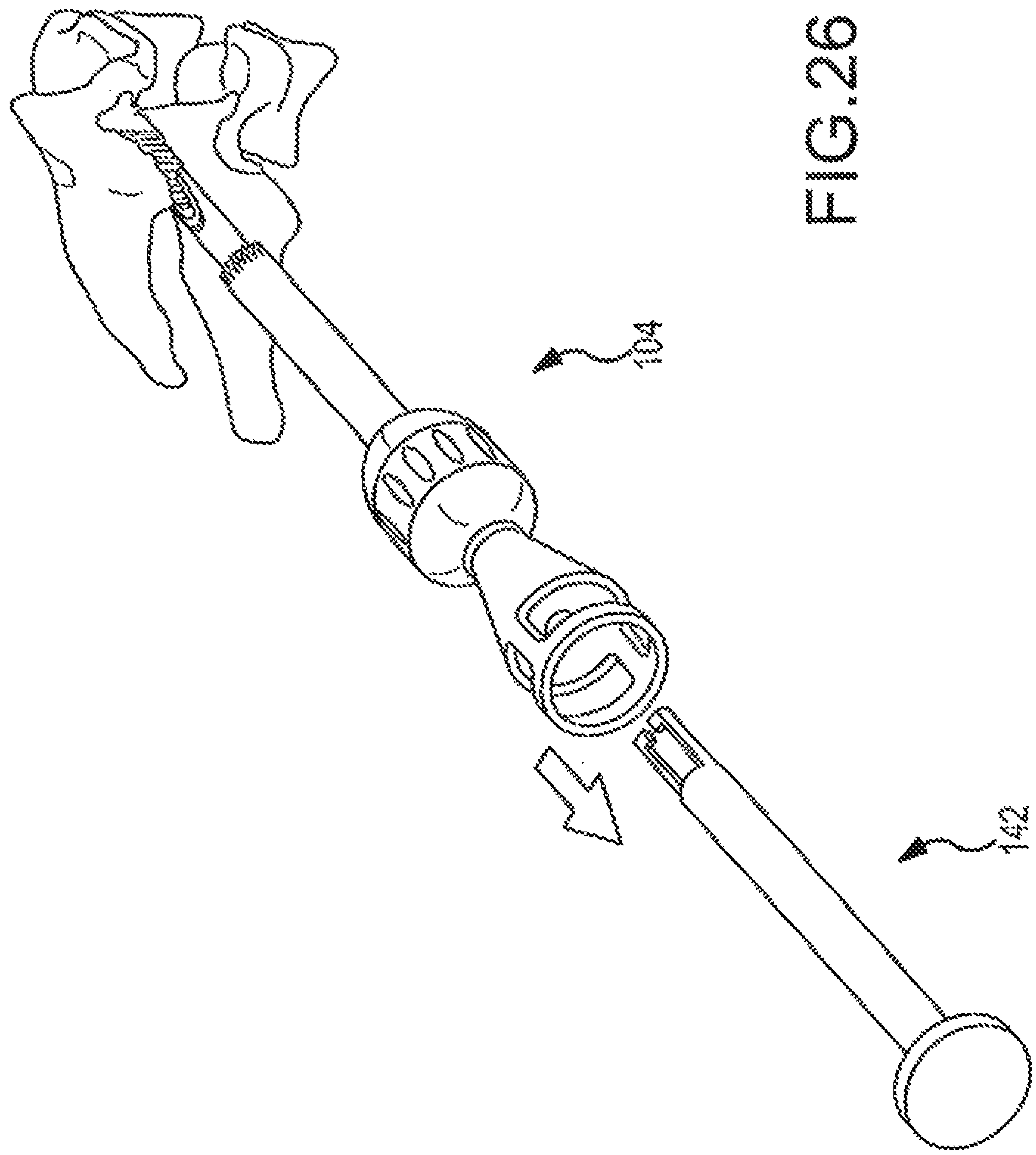
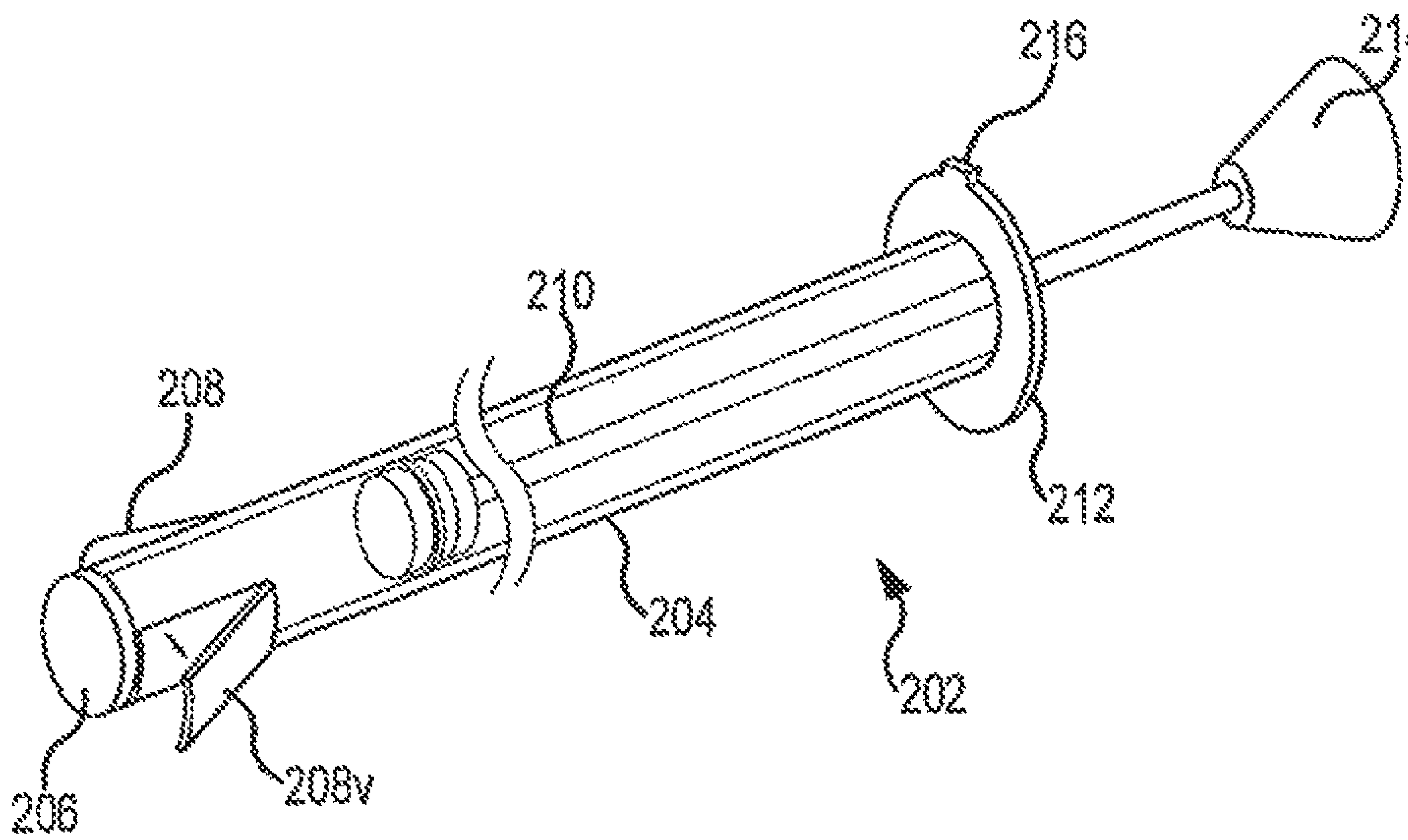


FIG.26



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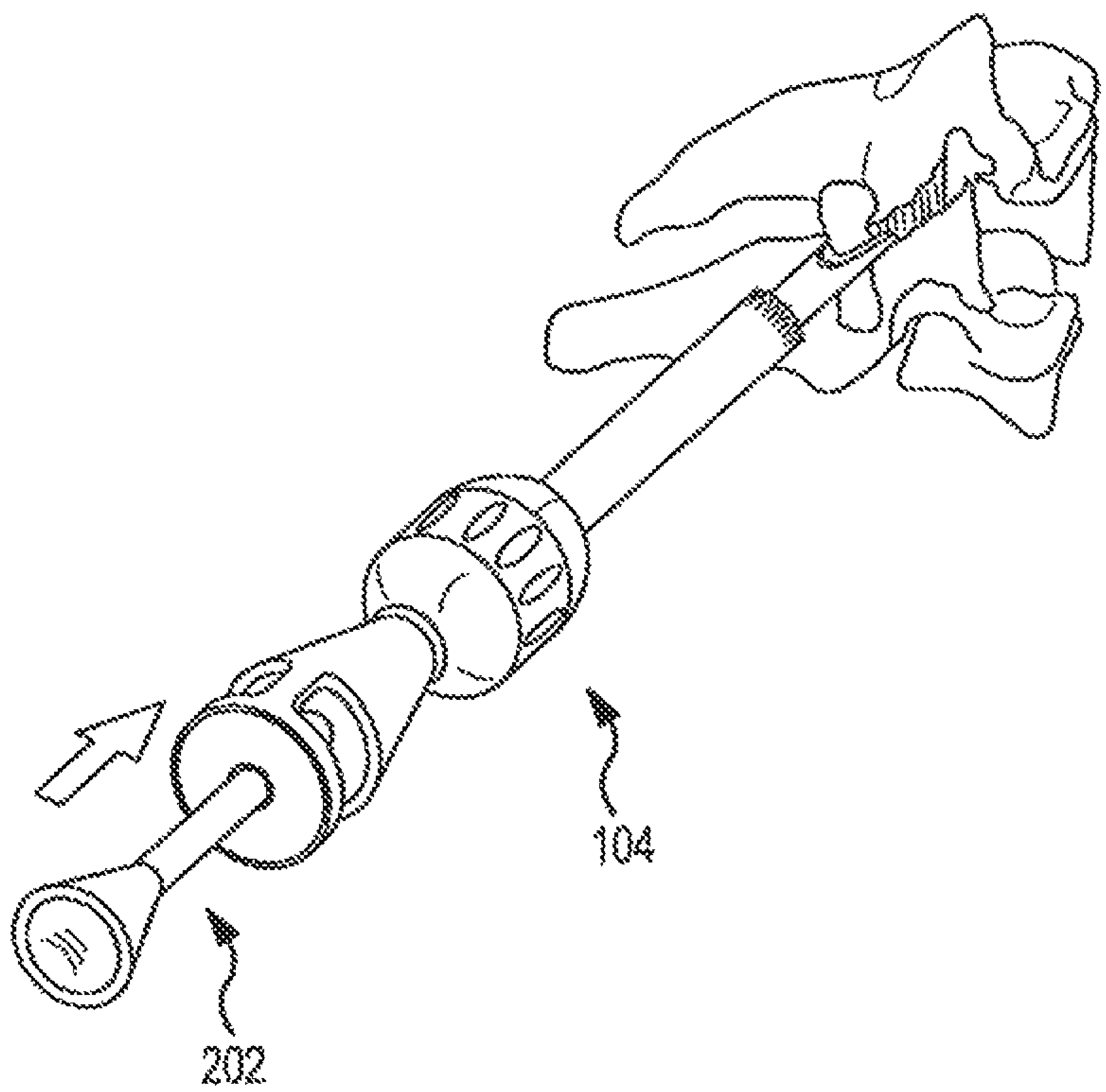

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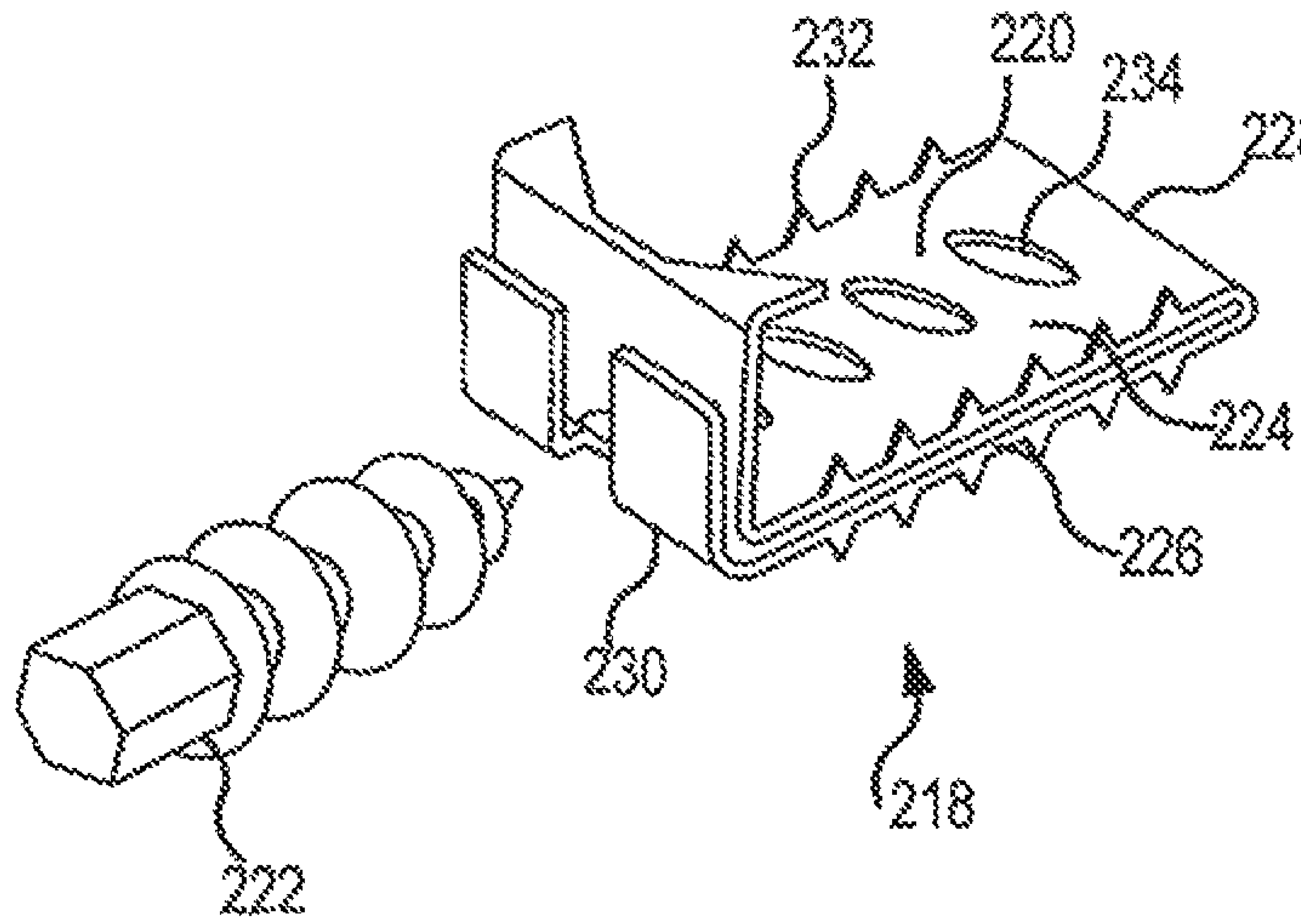
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FIG.29

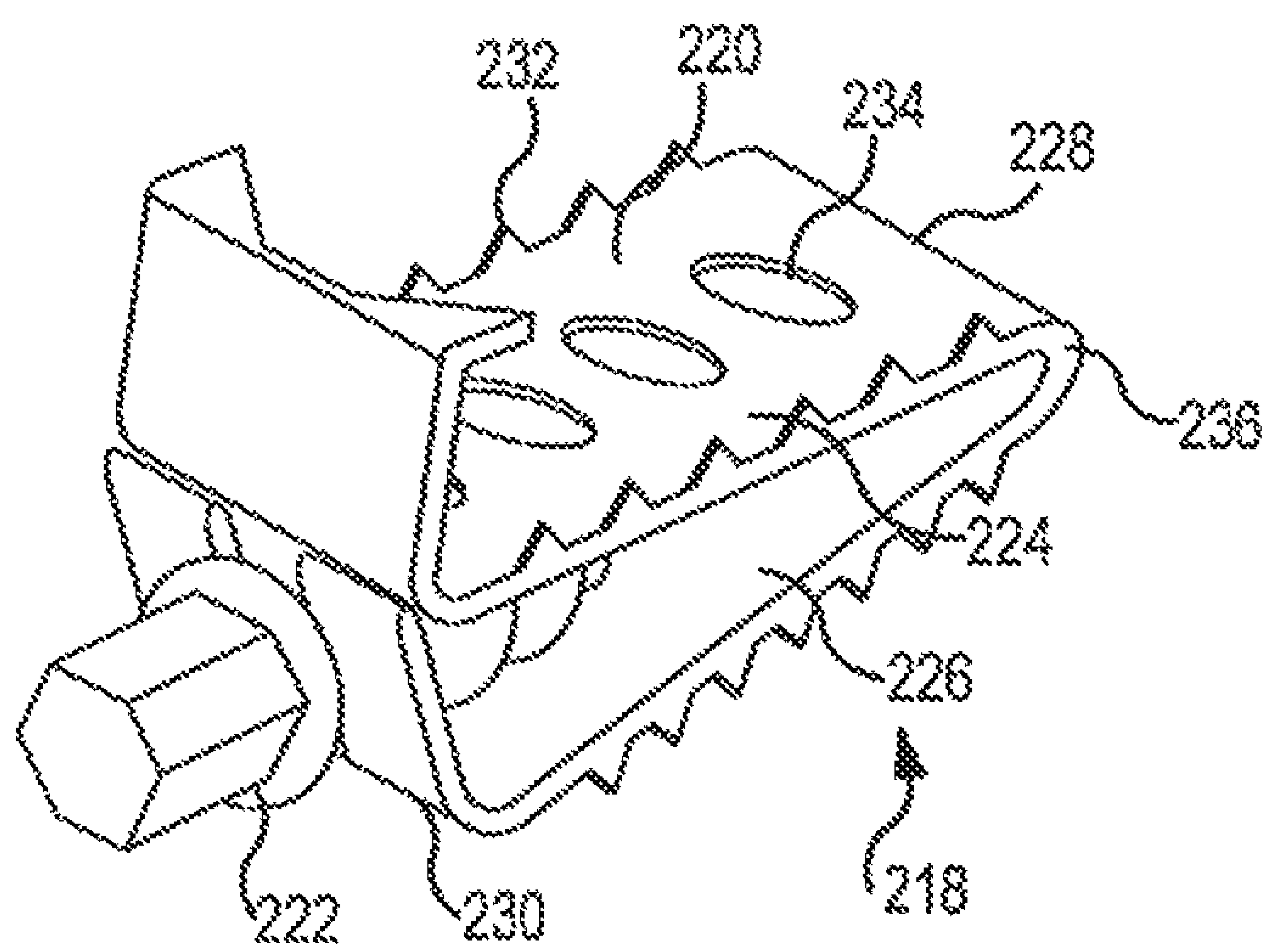
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FIG.30

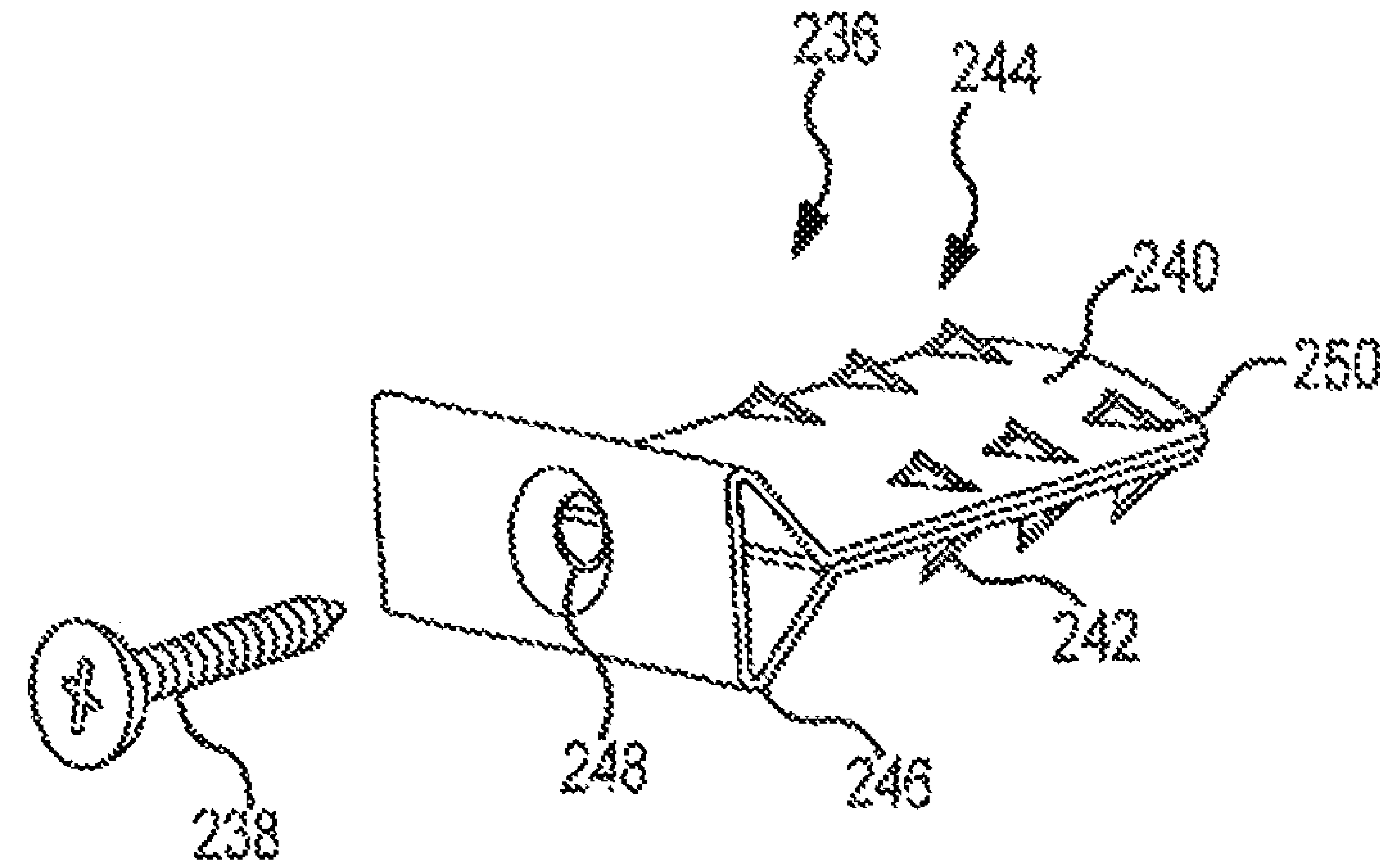
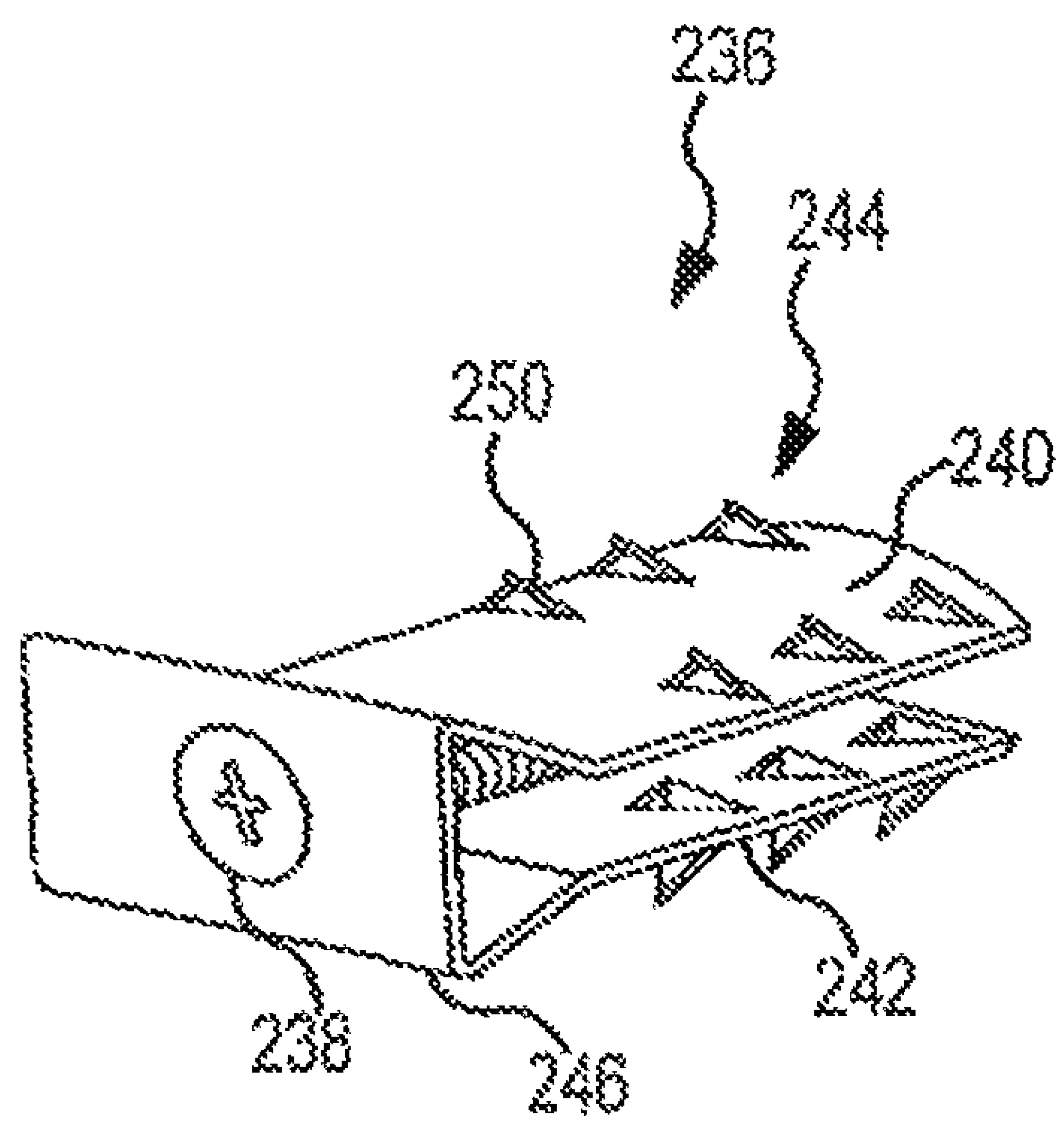


FIG.31



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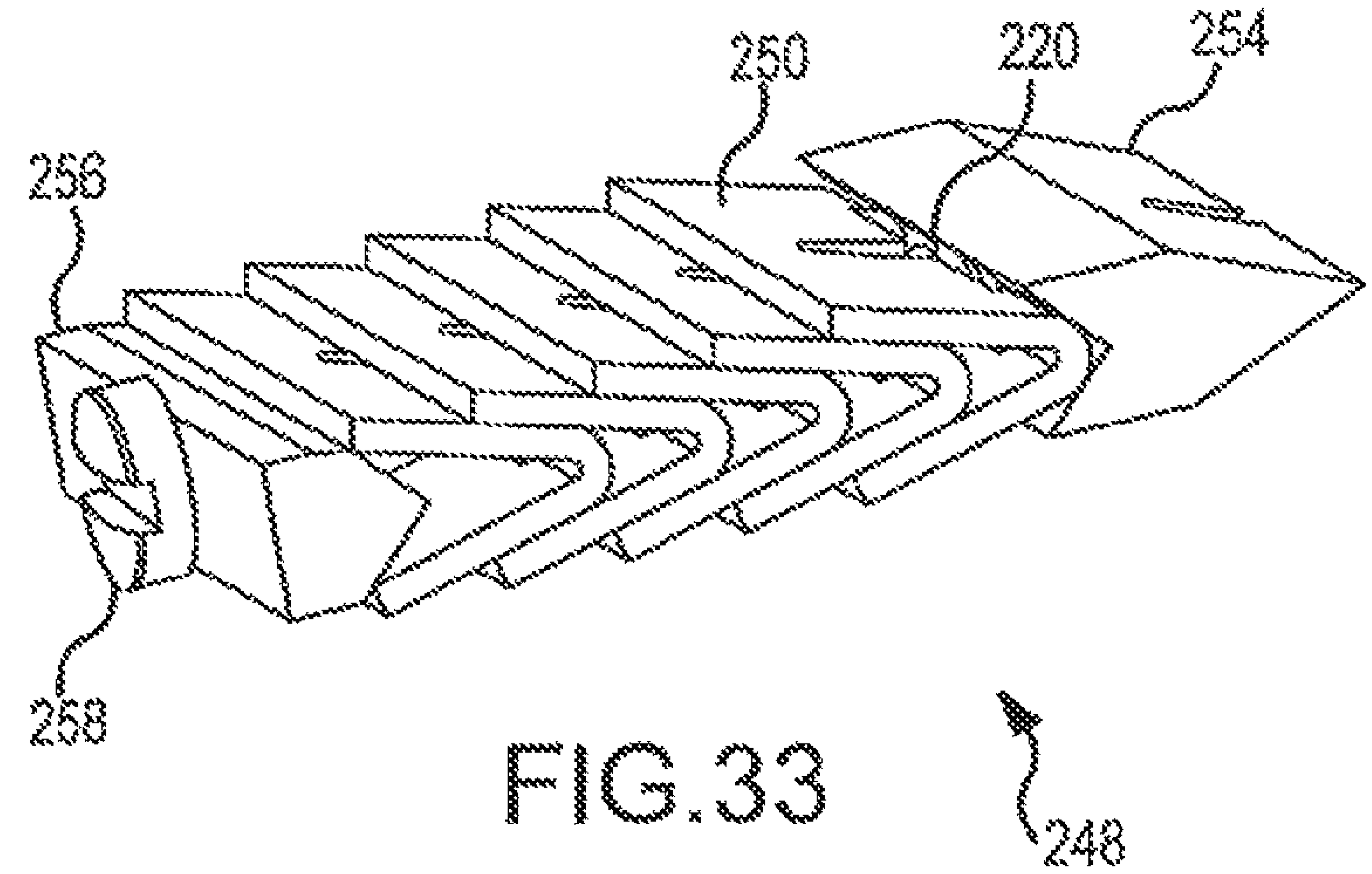

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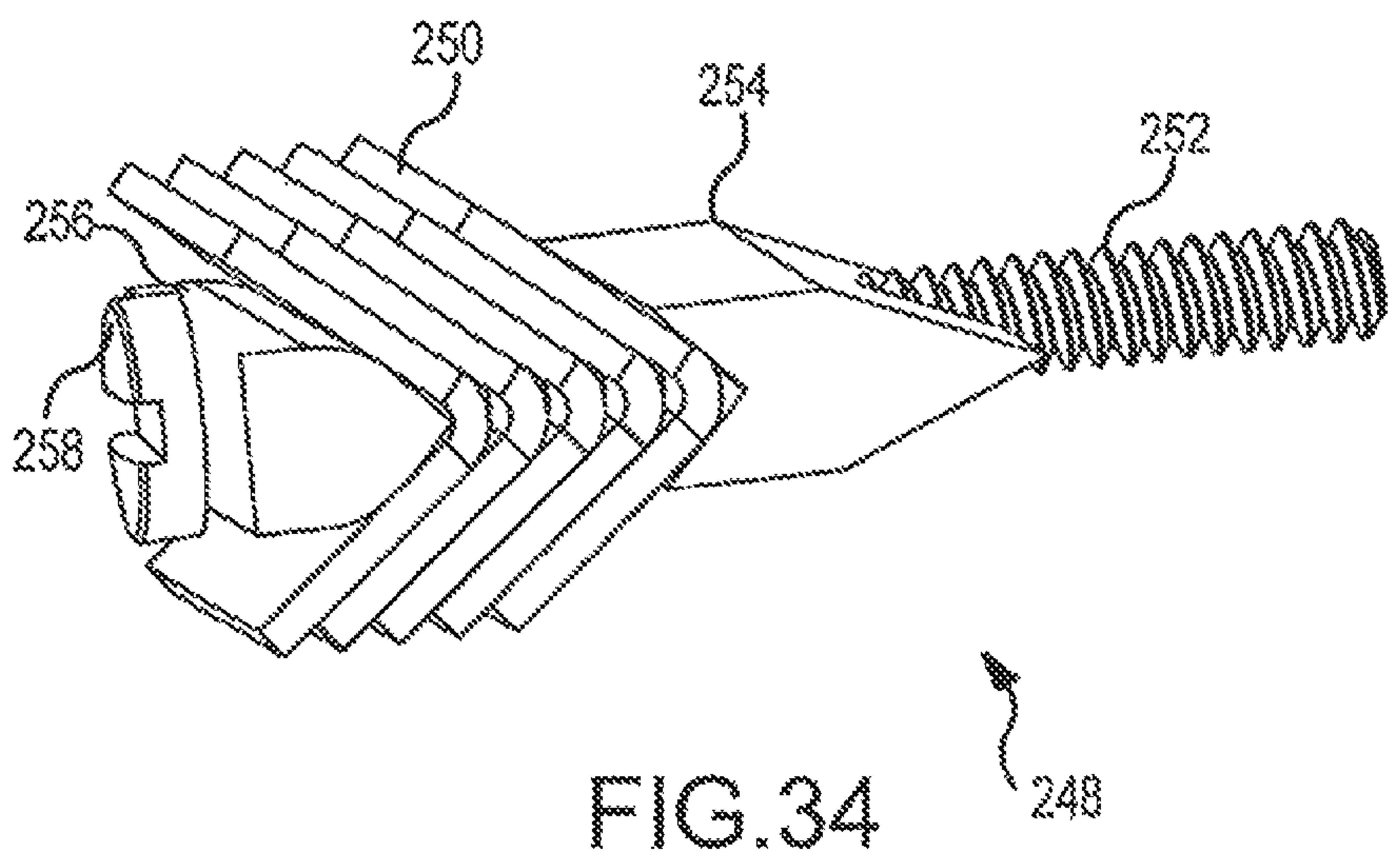

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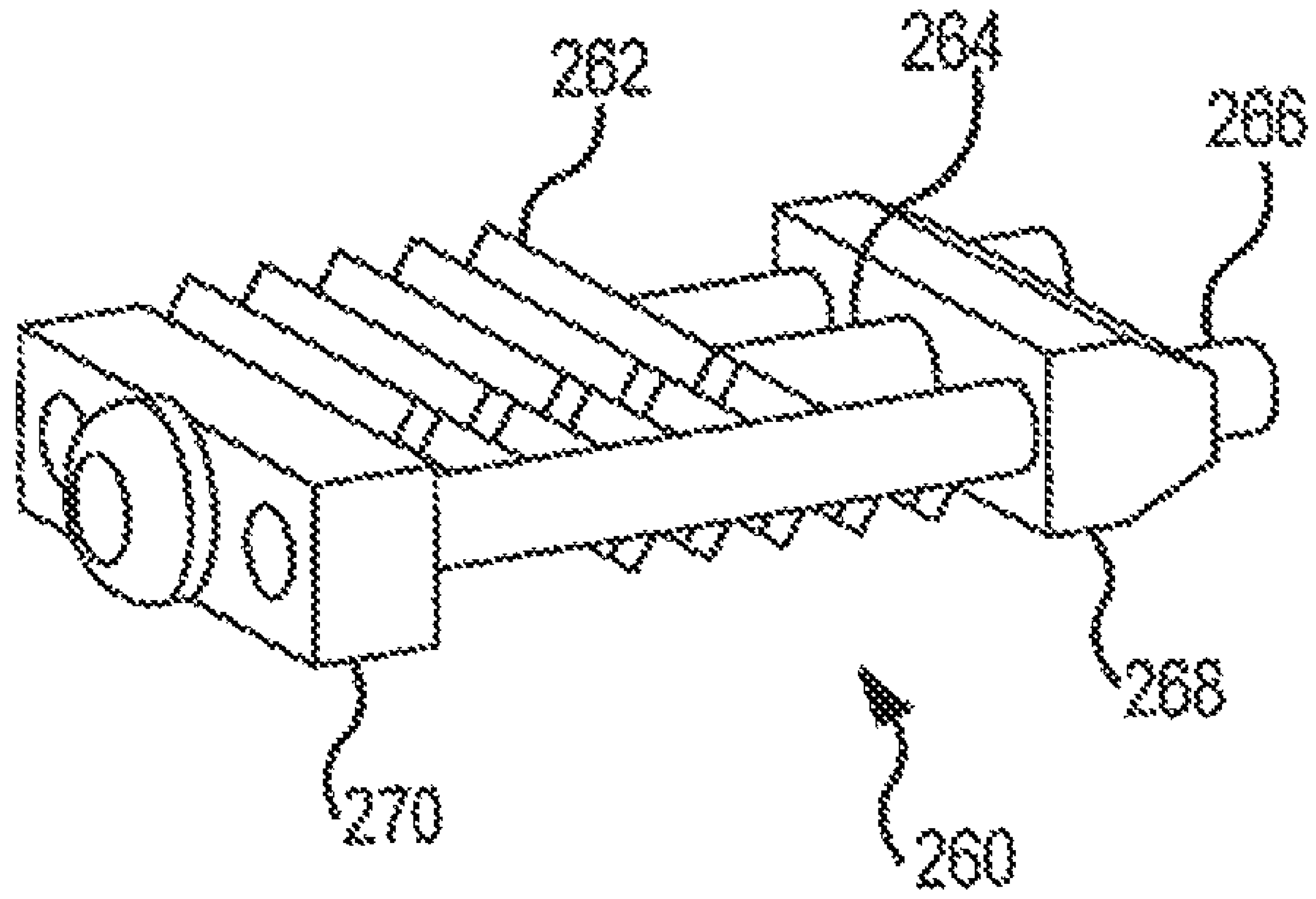

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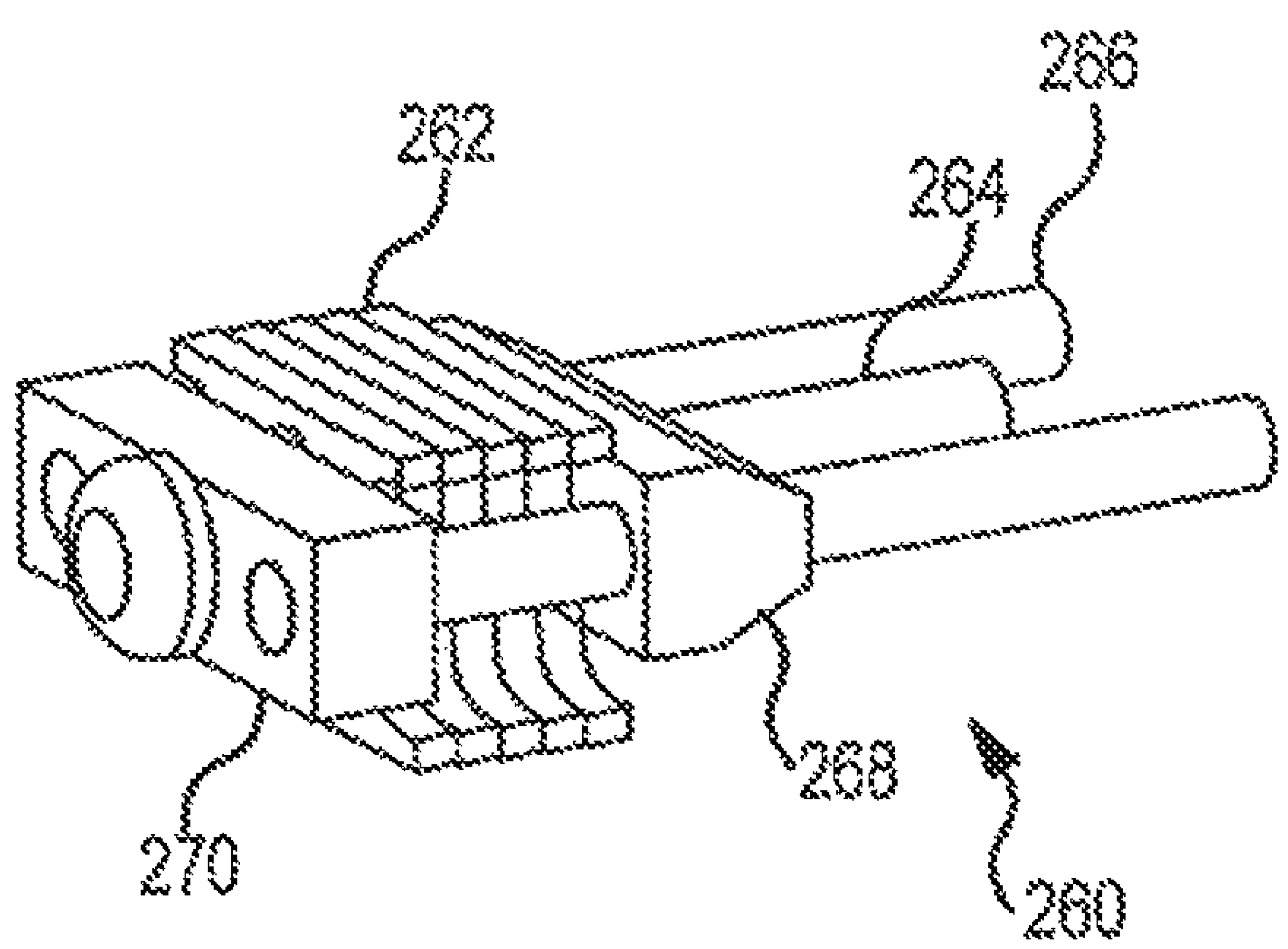

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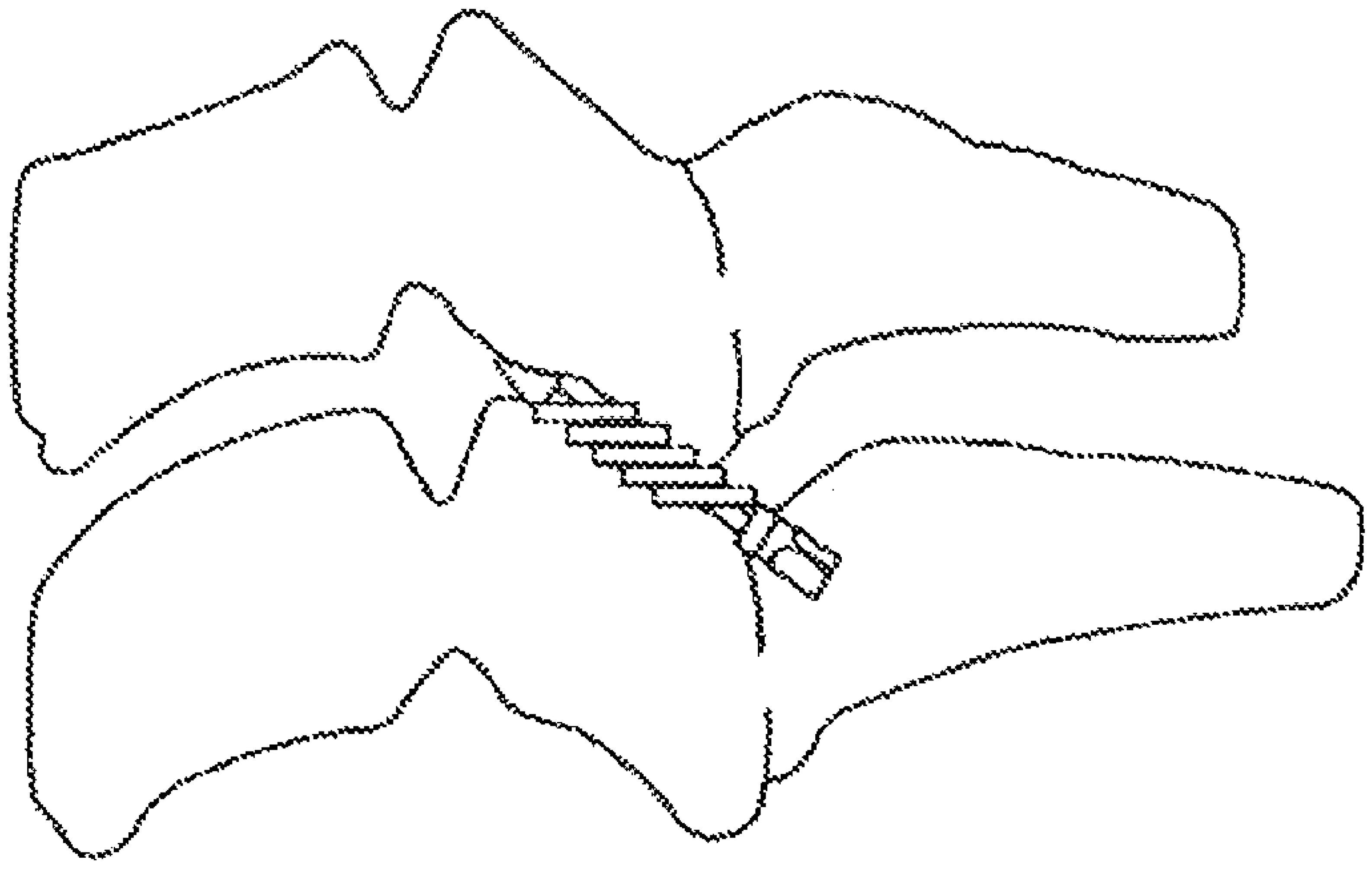


FIG.37A

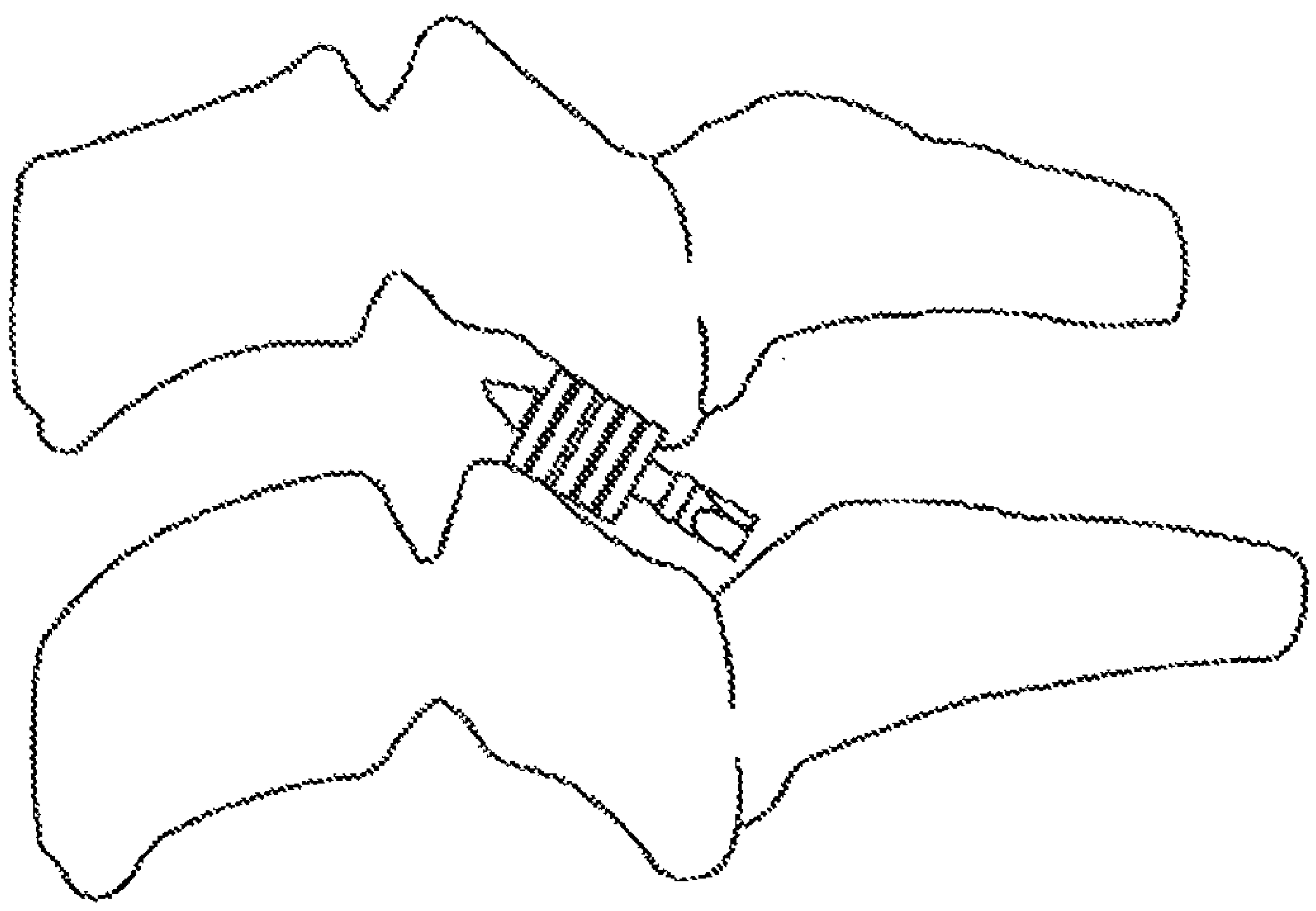


FIG.37B

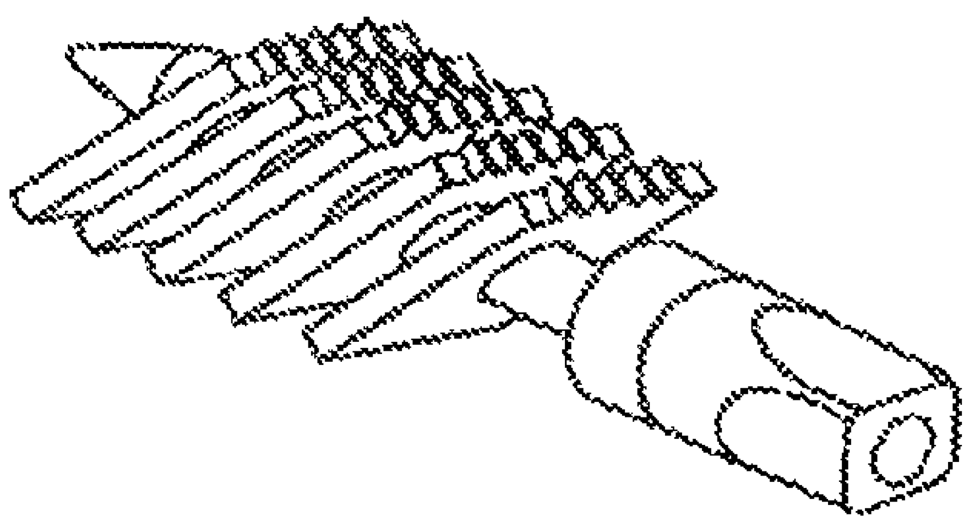


FIG.37C

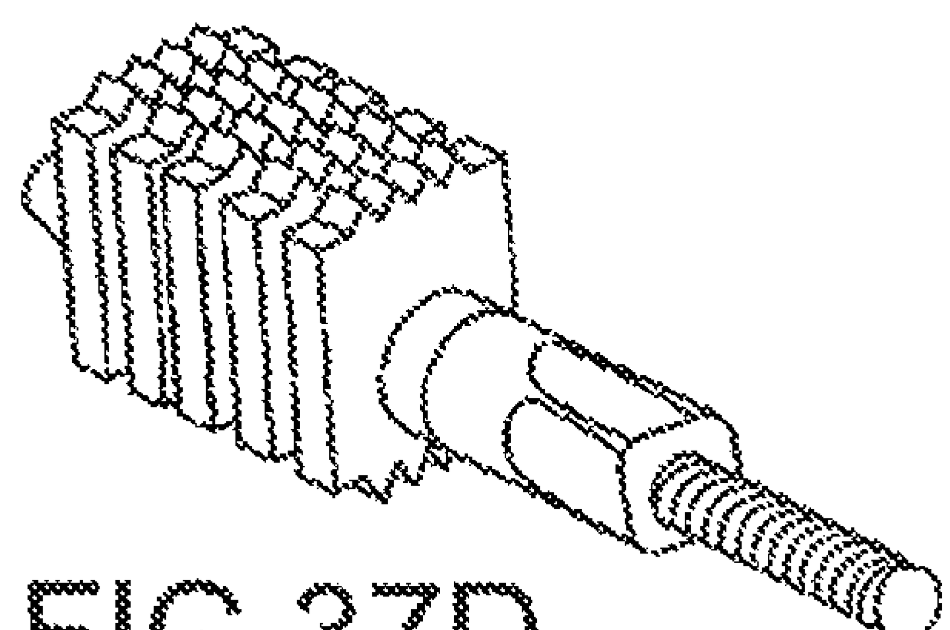


FIG.37D

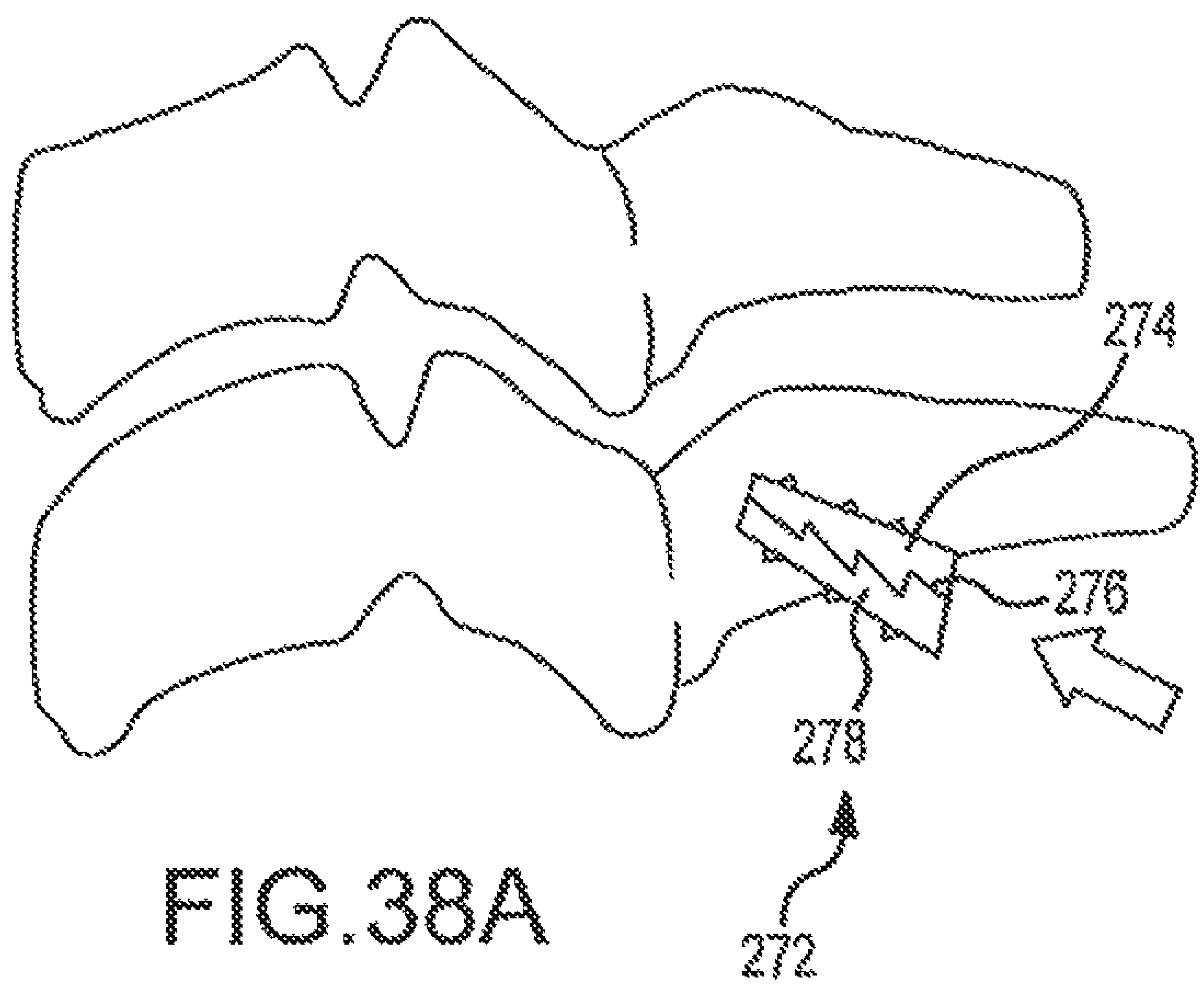


FIG.38A

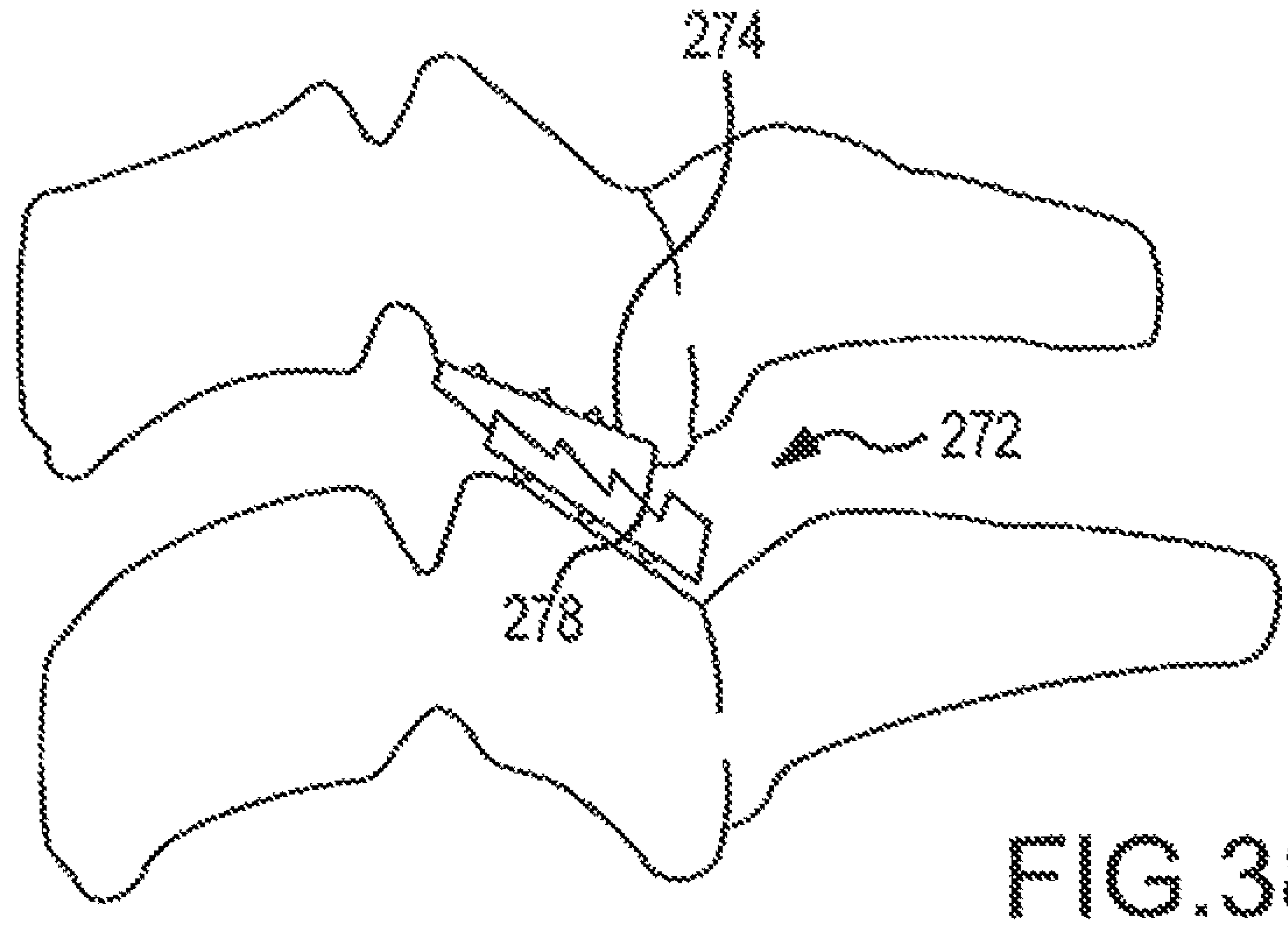


FIG.38B

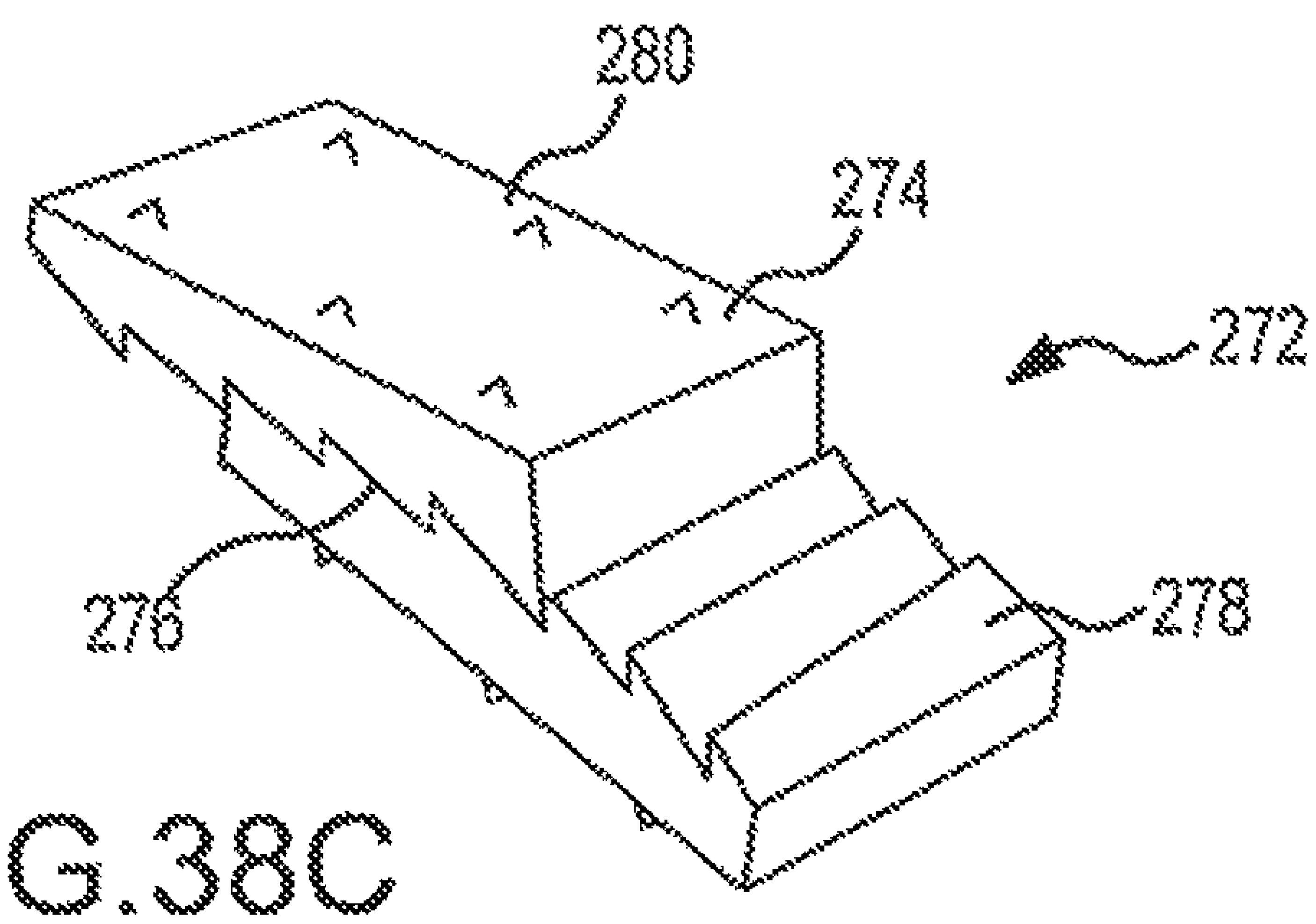


FIG.38C

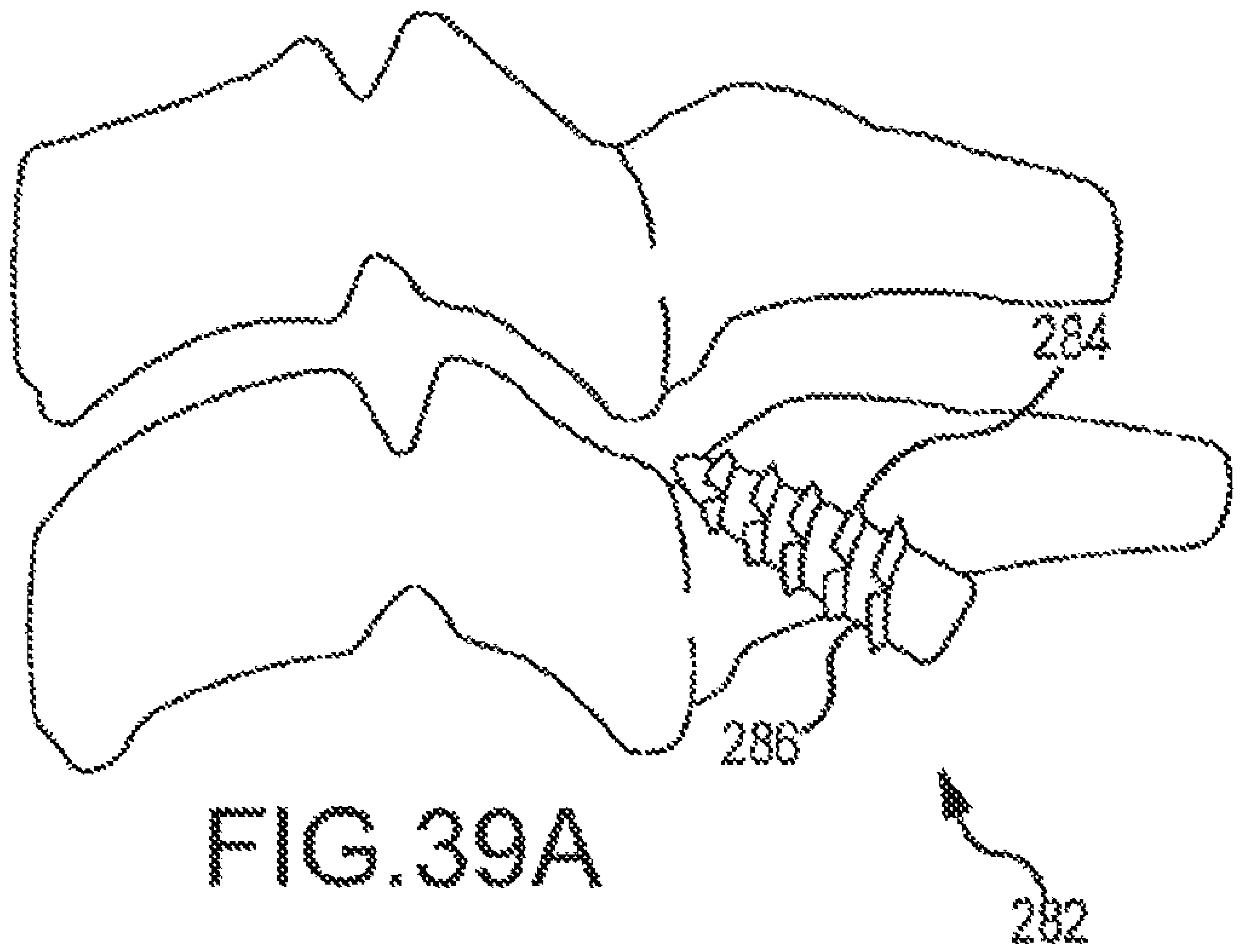


FIG.39A

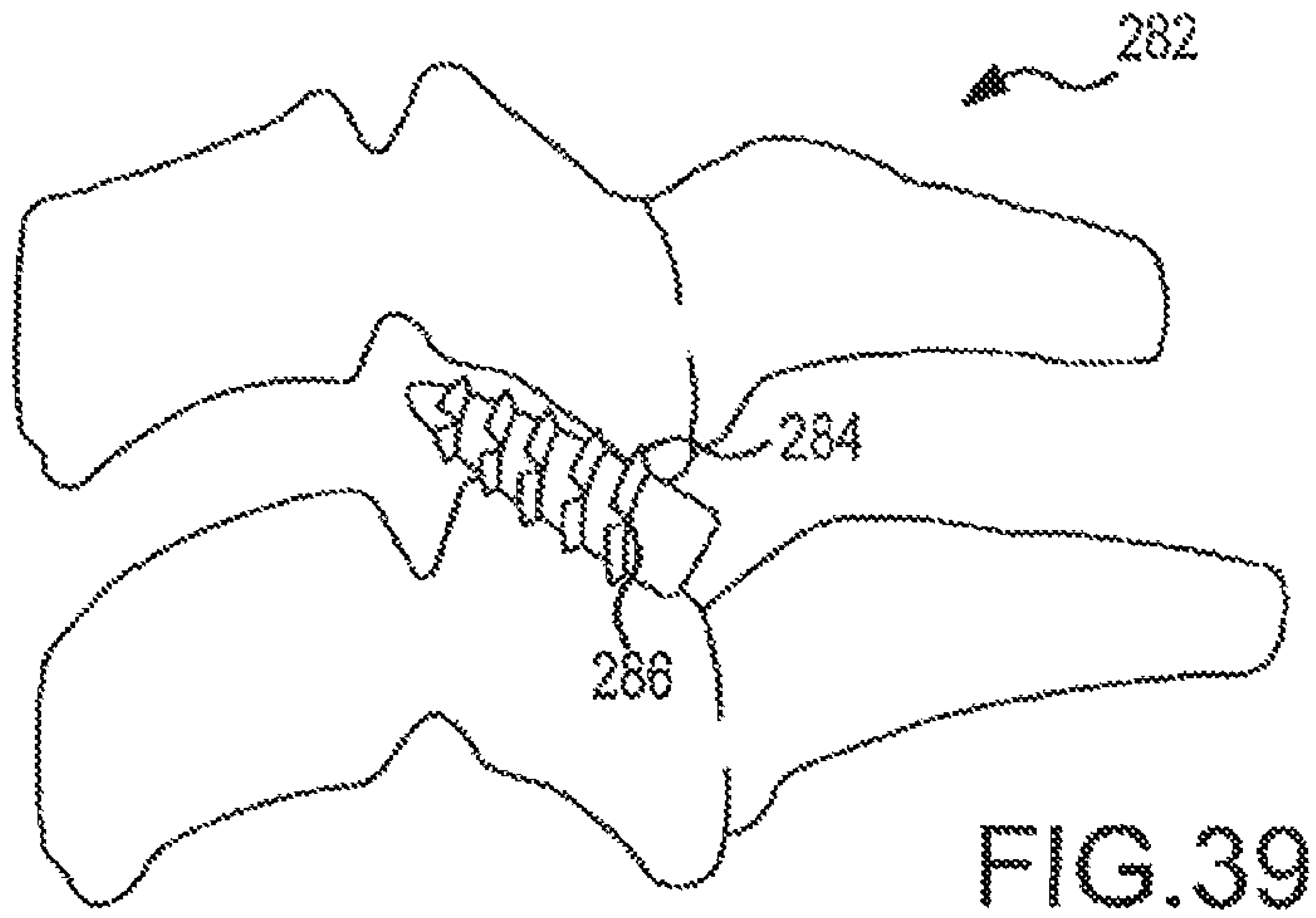
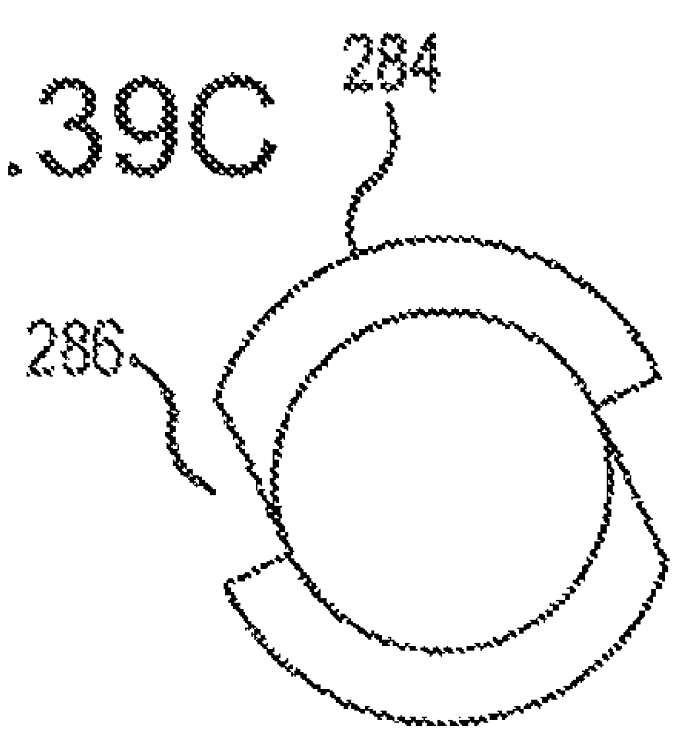


FIG.39B

FIG.39C



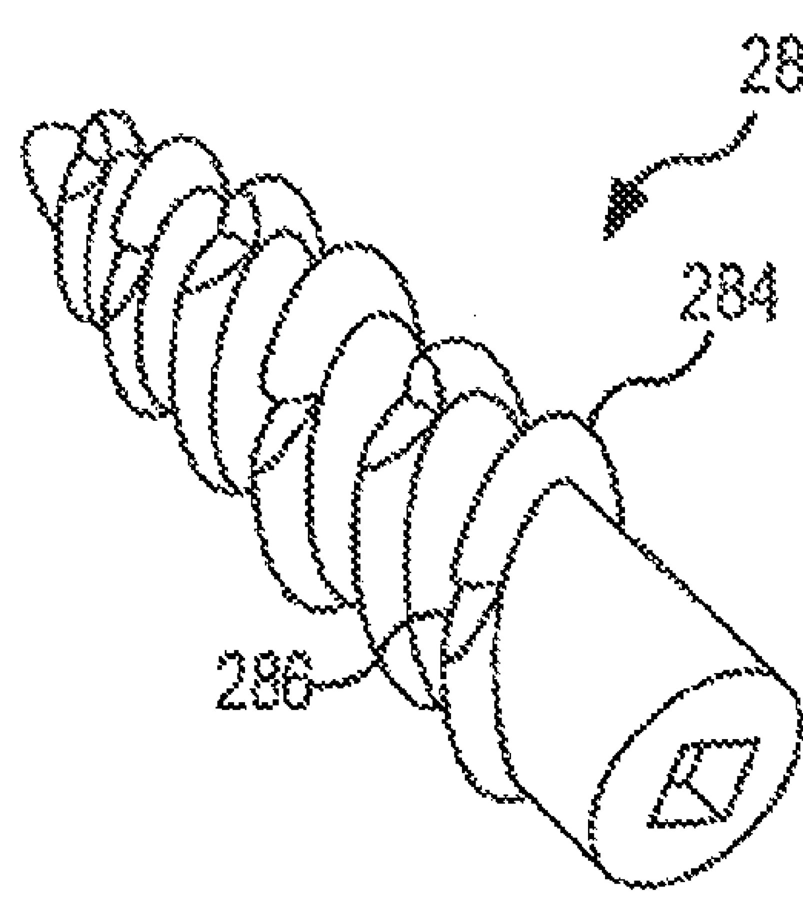


FIG.39D

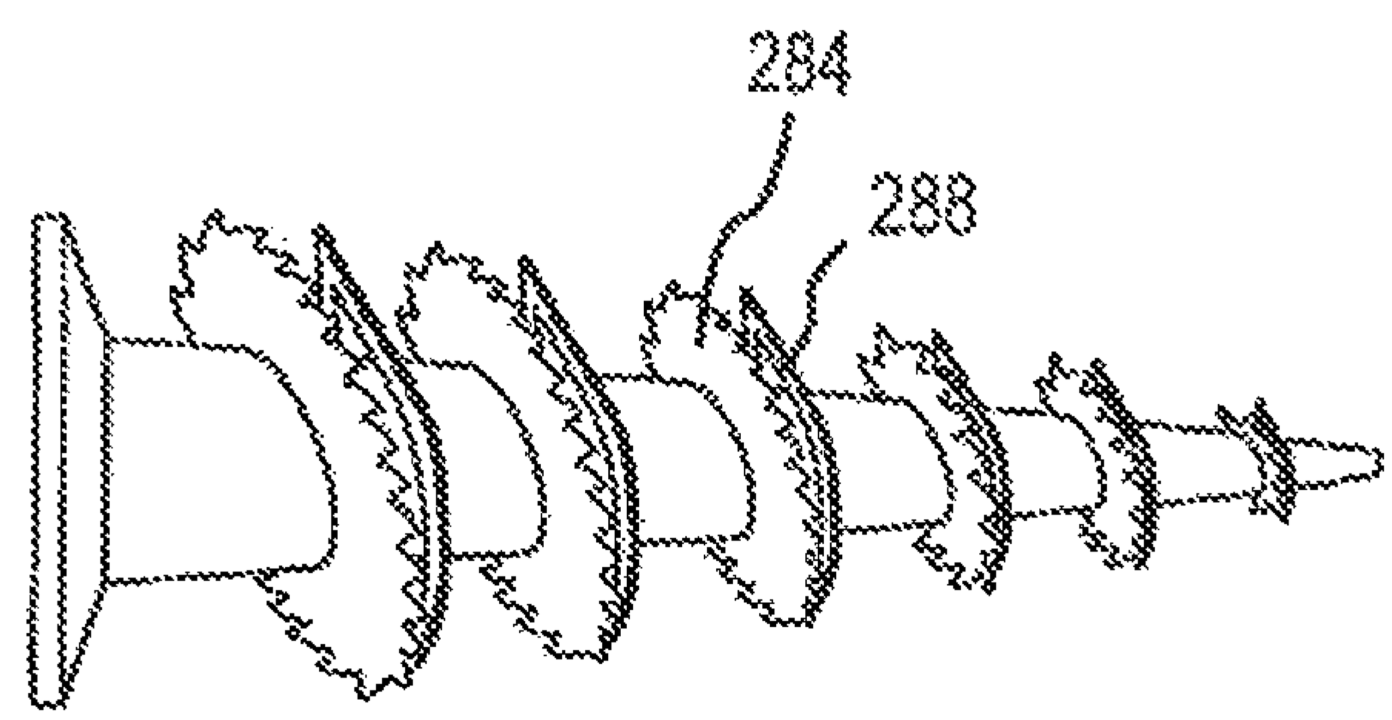


FIG.40A

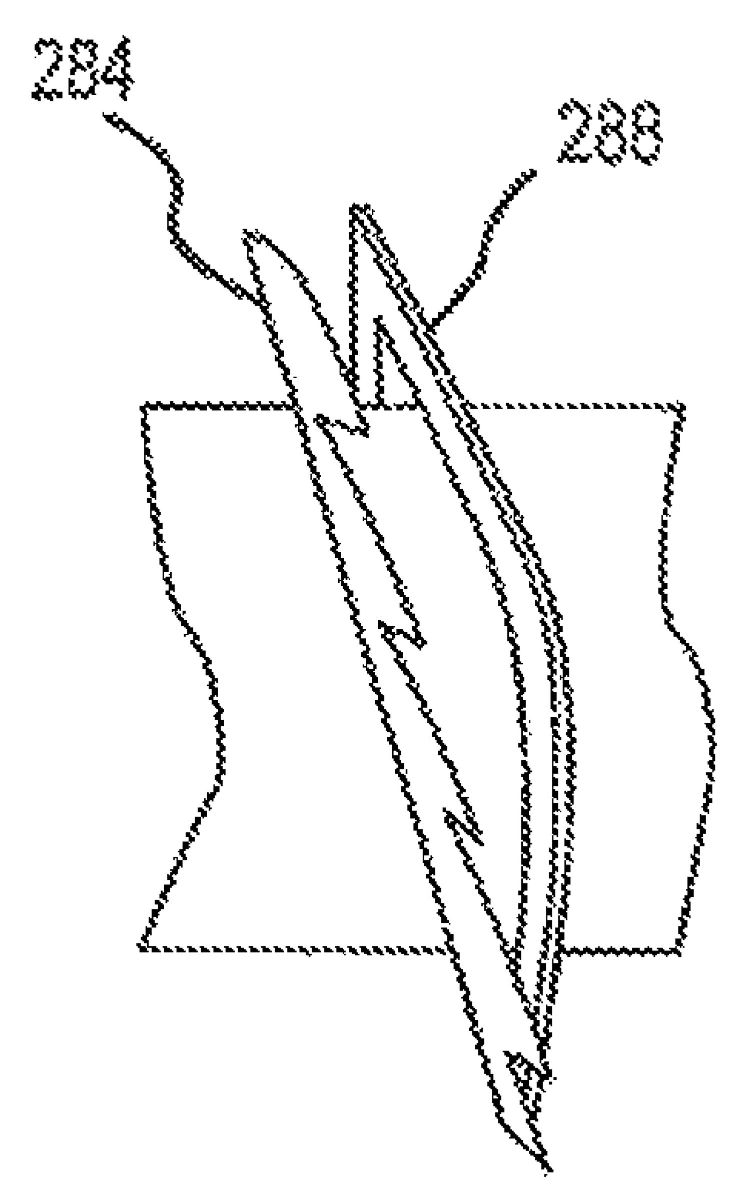


FIG.40B

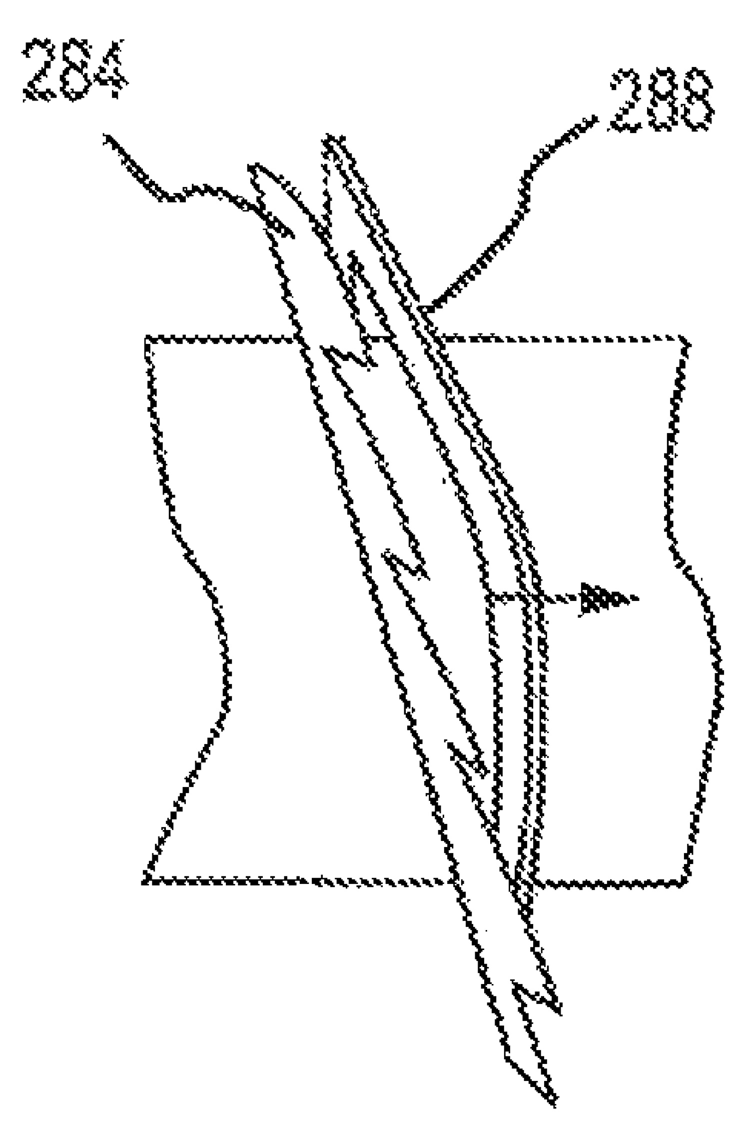


FIG.40C

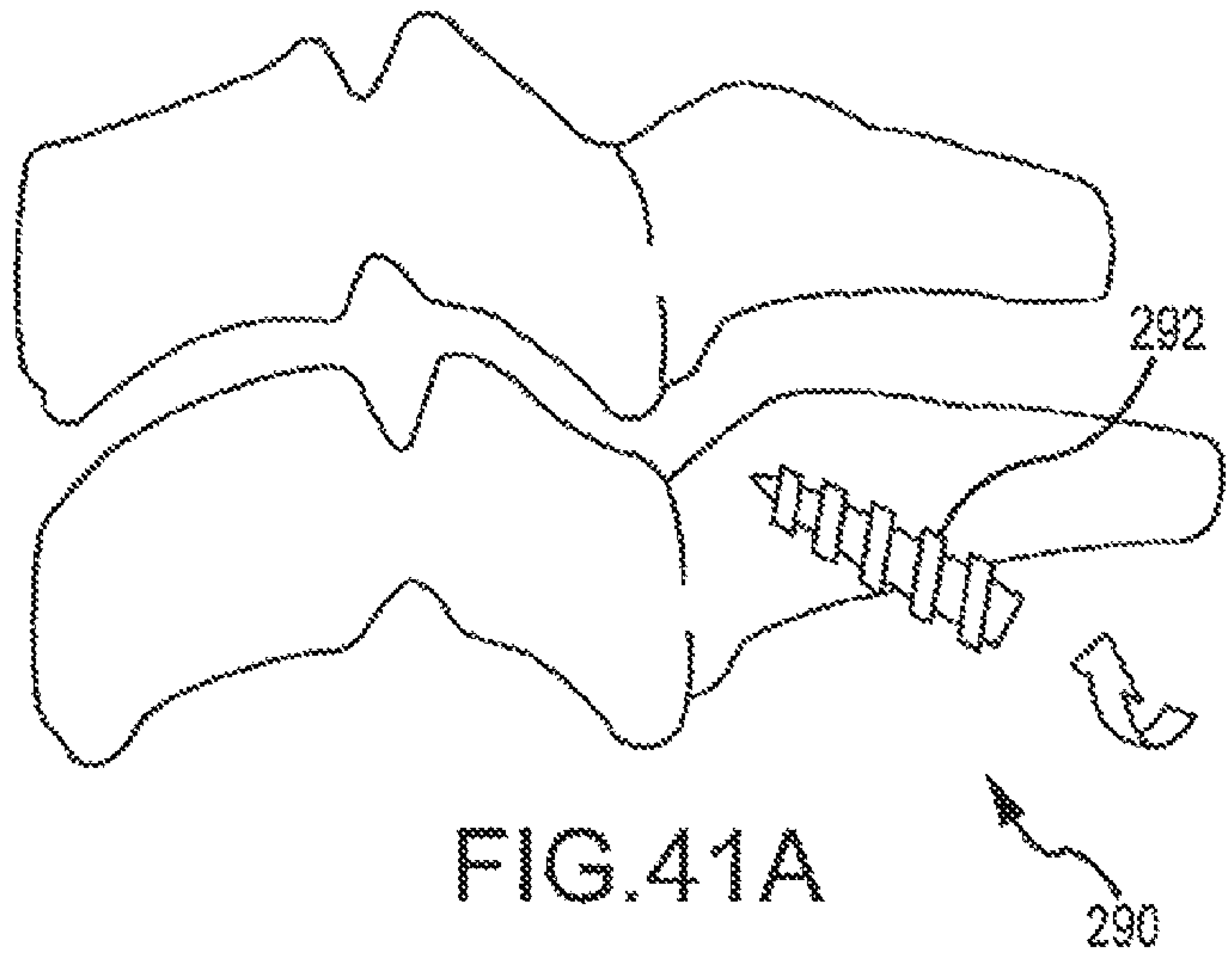


FIG.41A

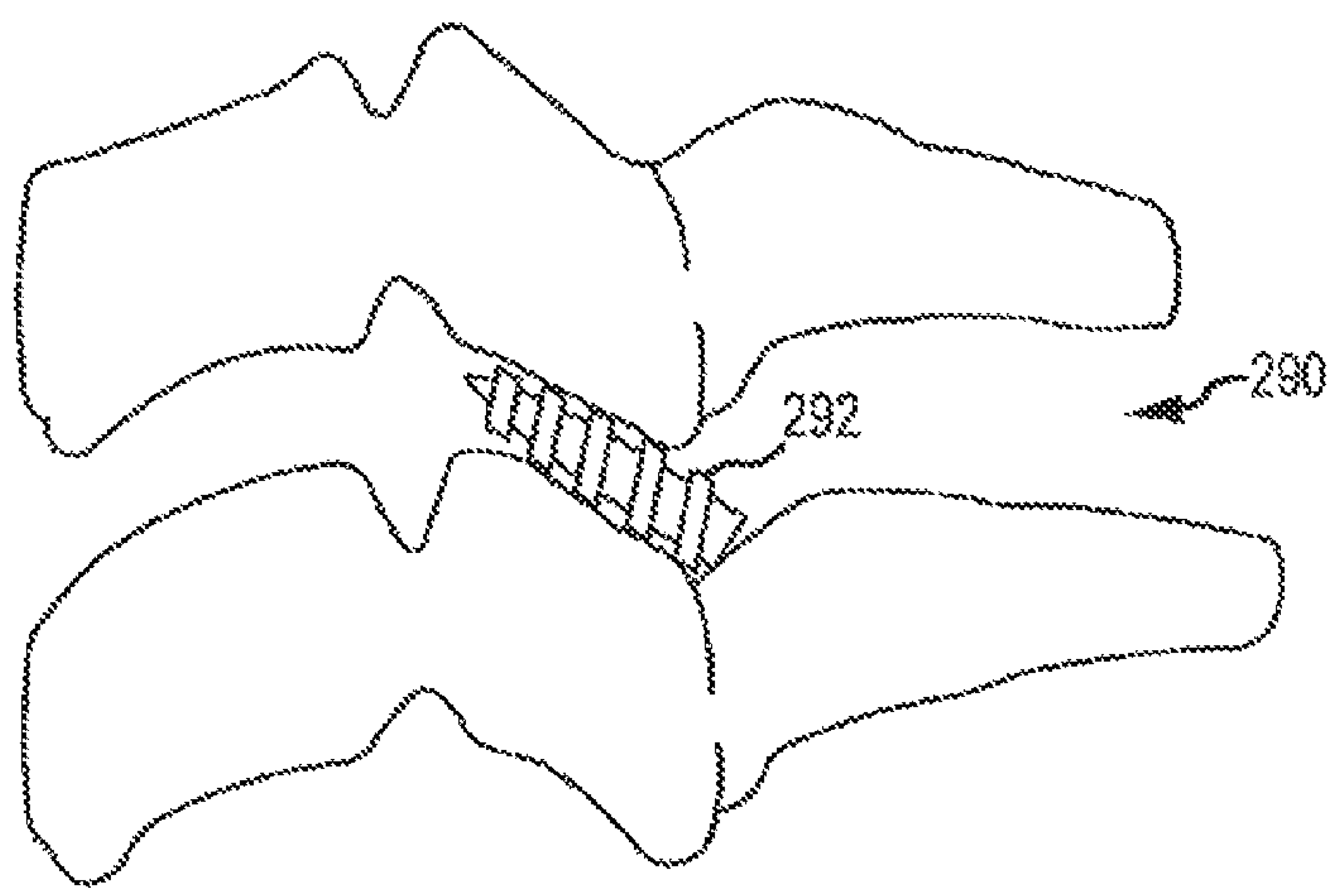


FIG.41B

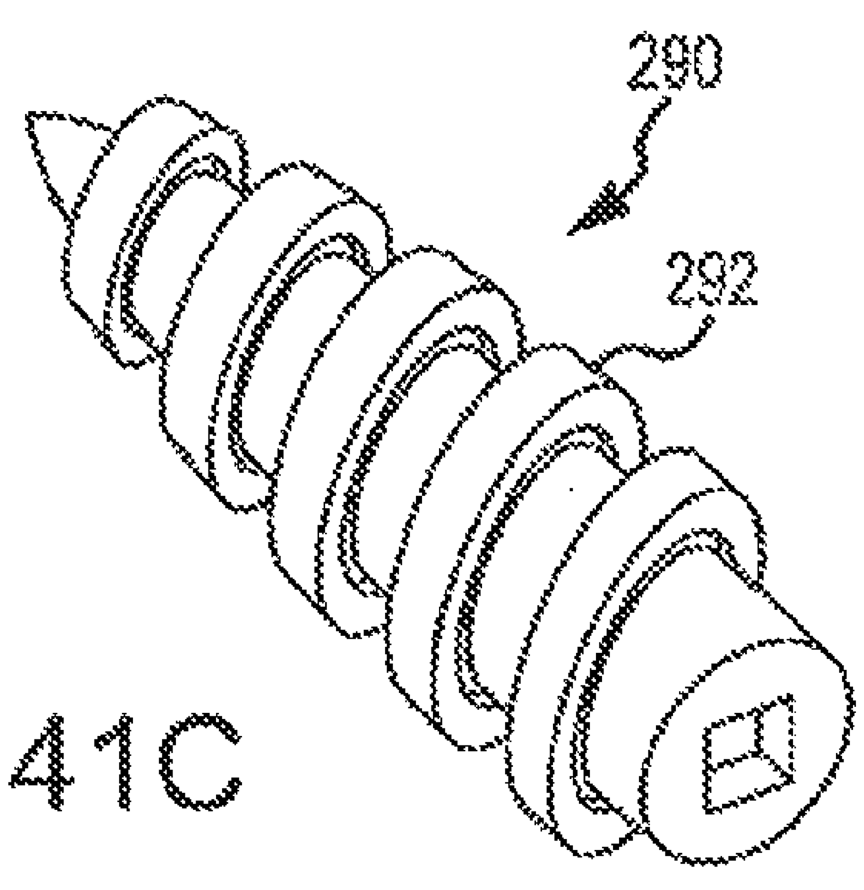


FIG.41C

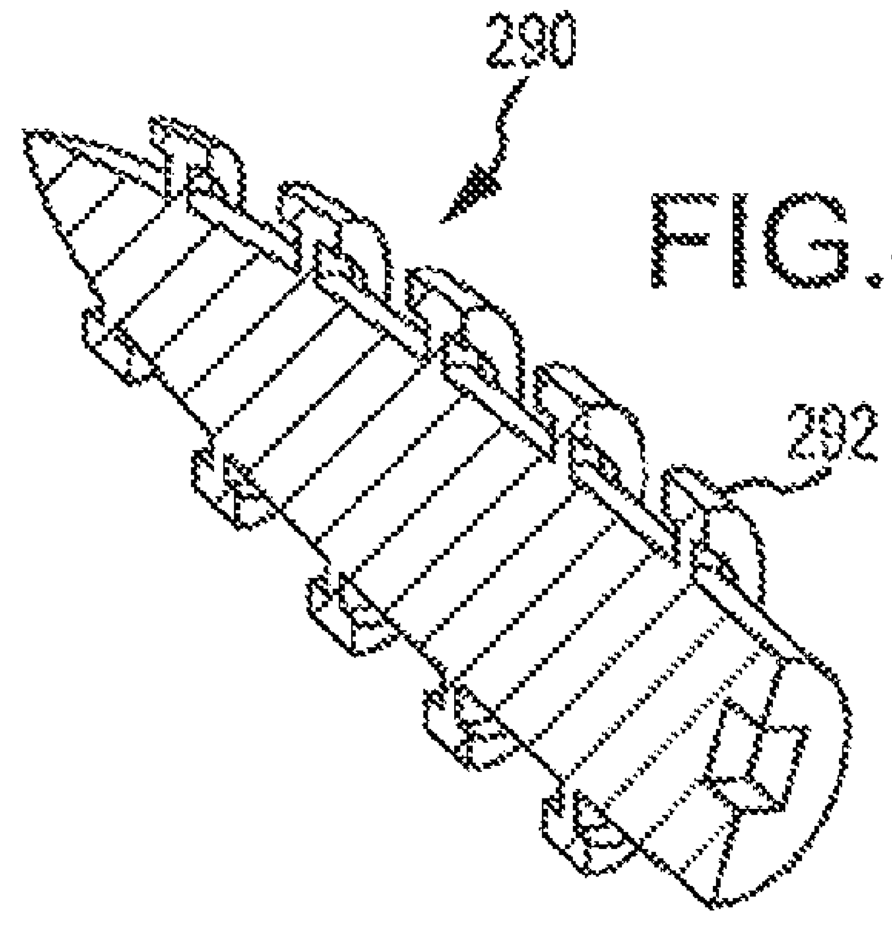


FIG.41D

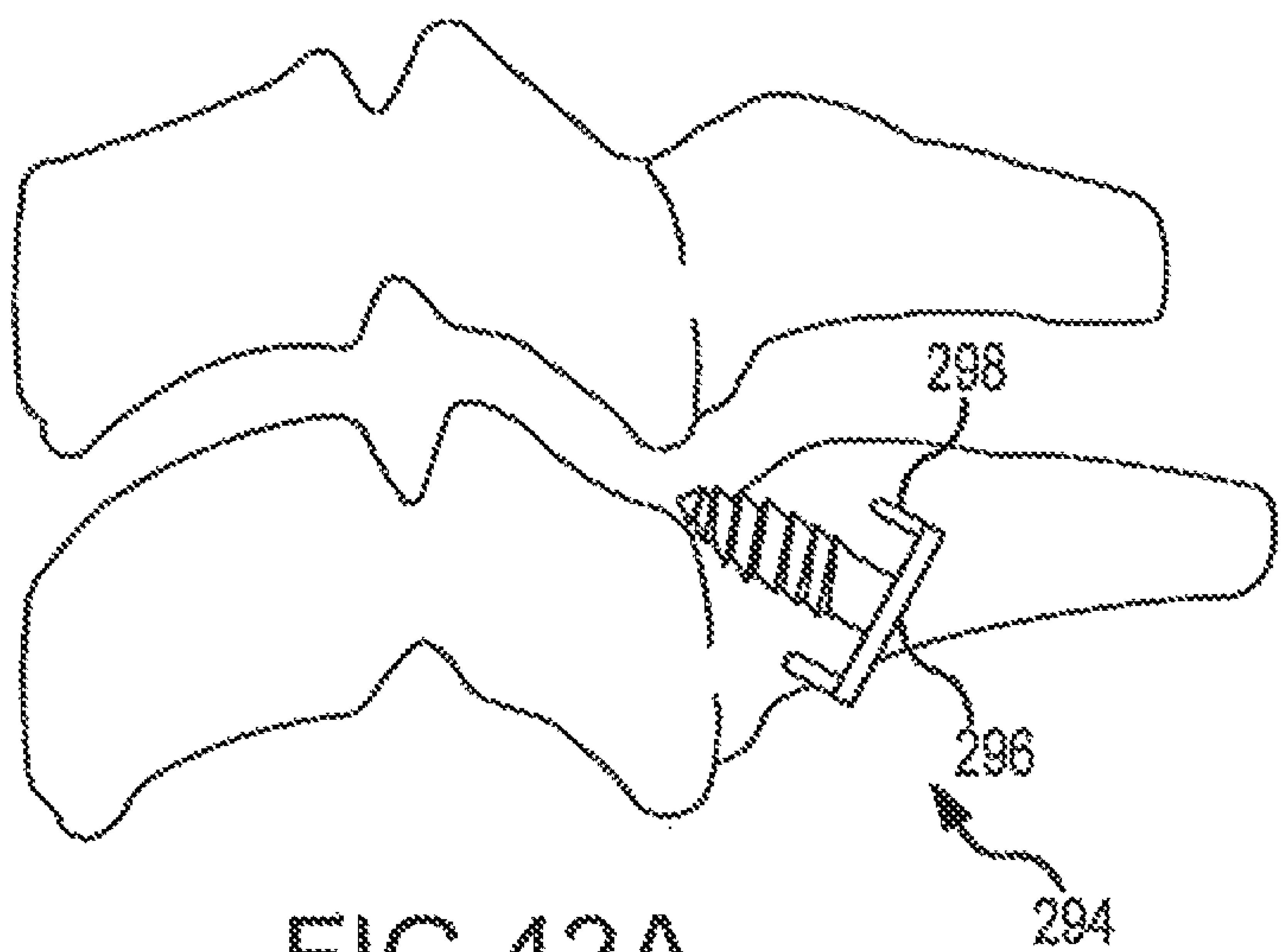


FIG.42A

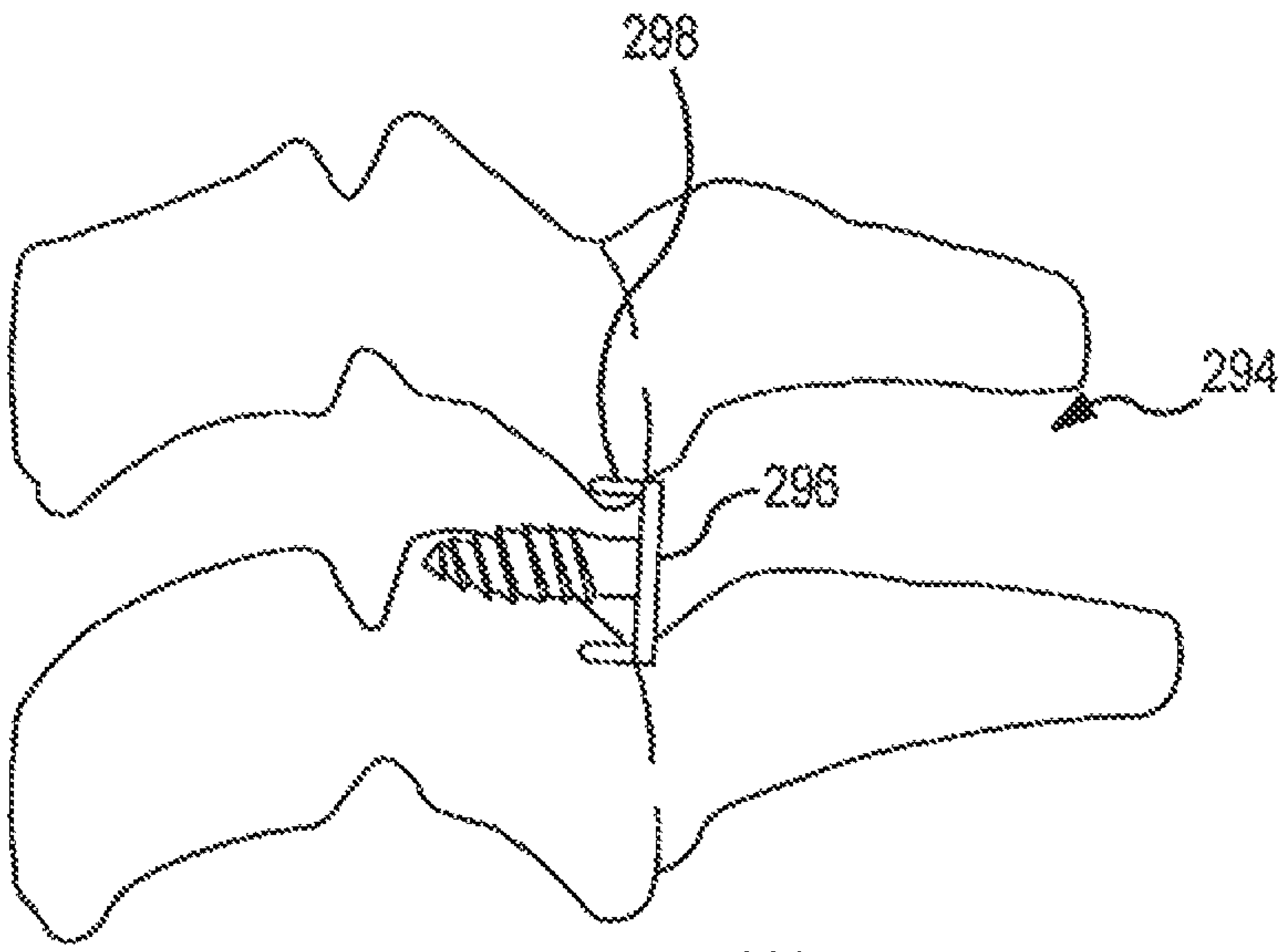


FIG.42B

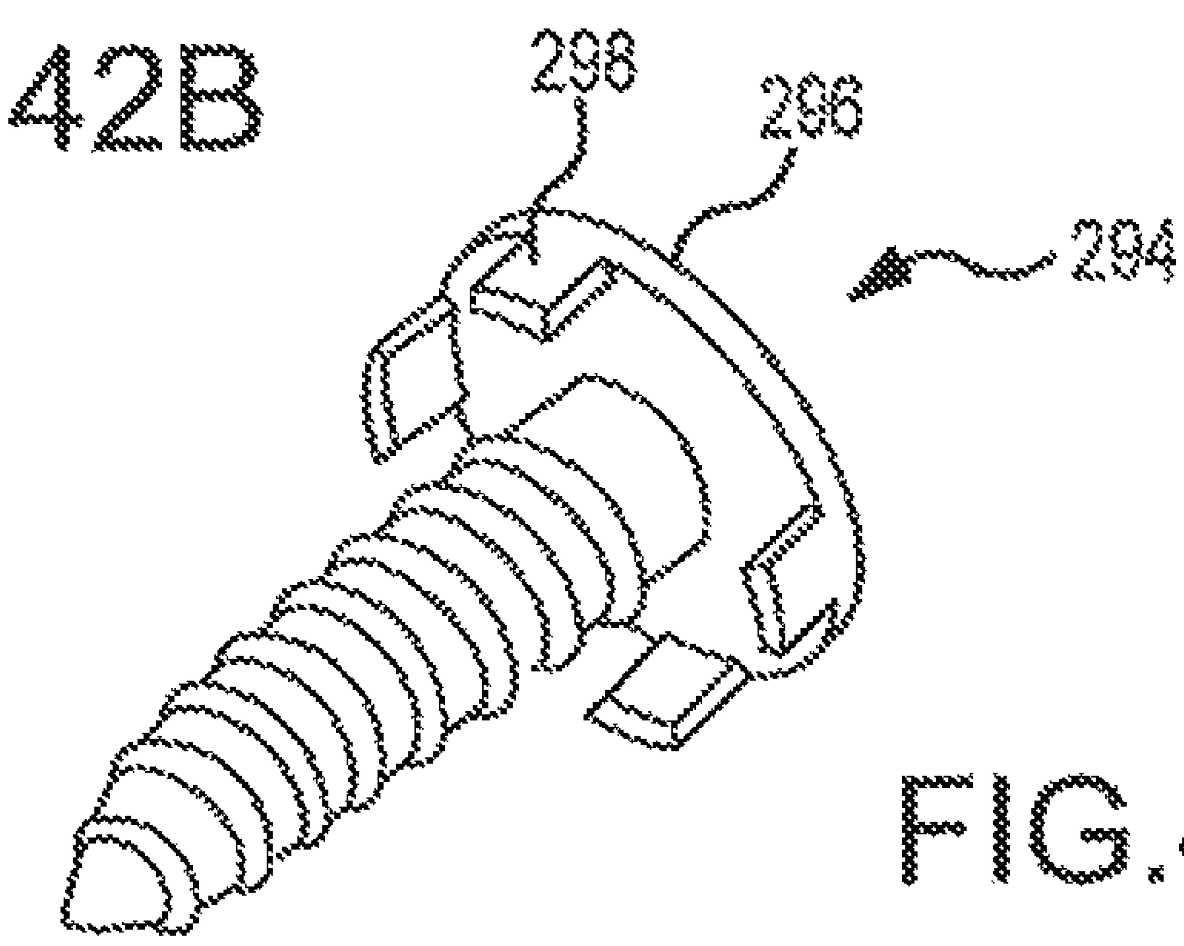


FIG.42C

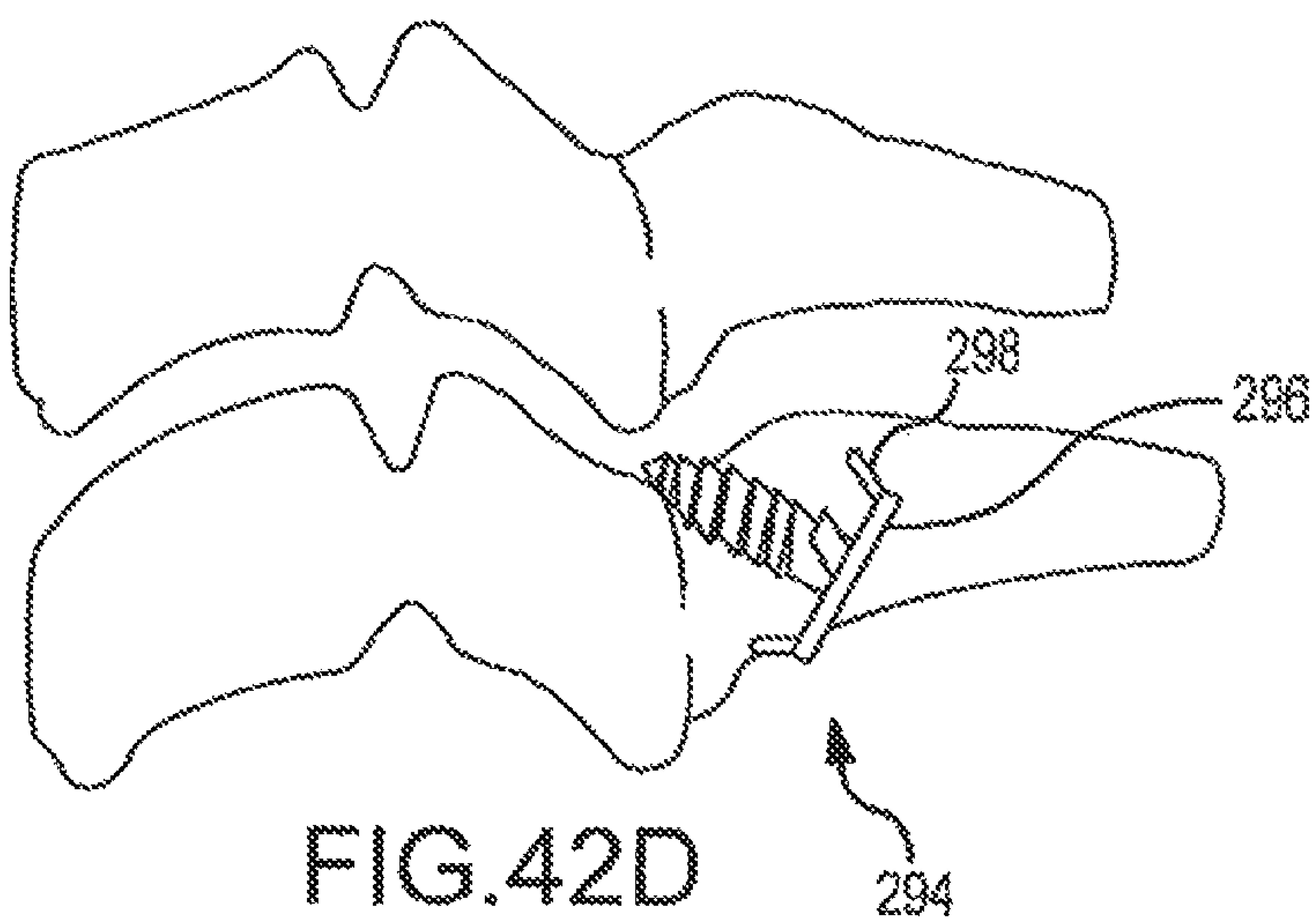


FIG.42D

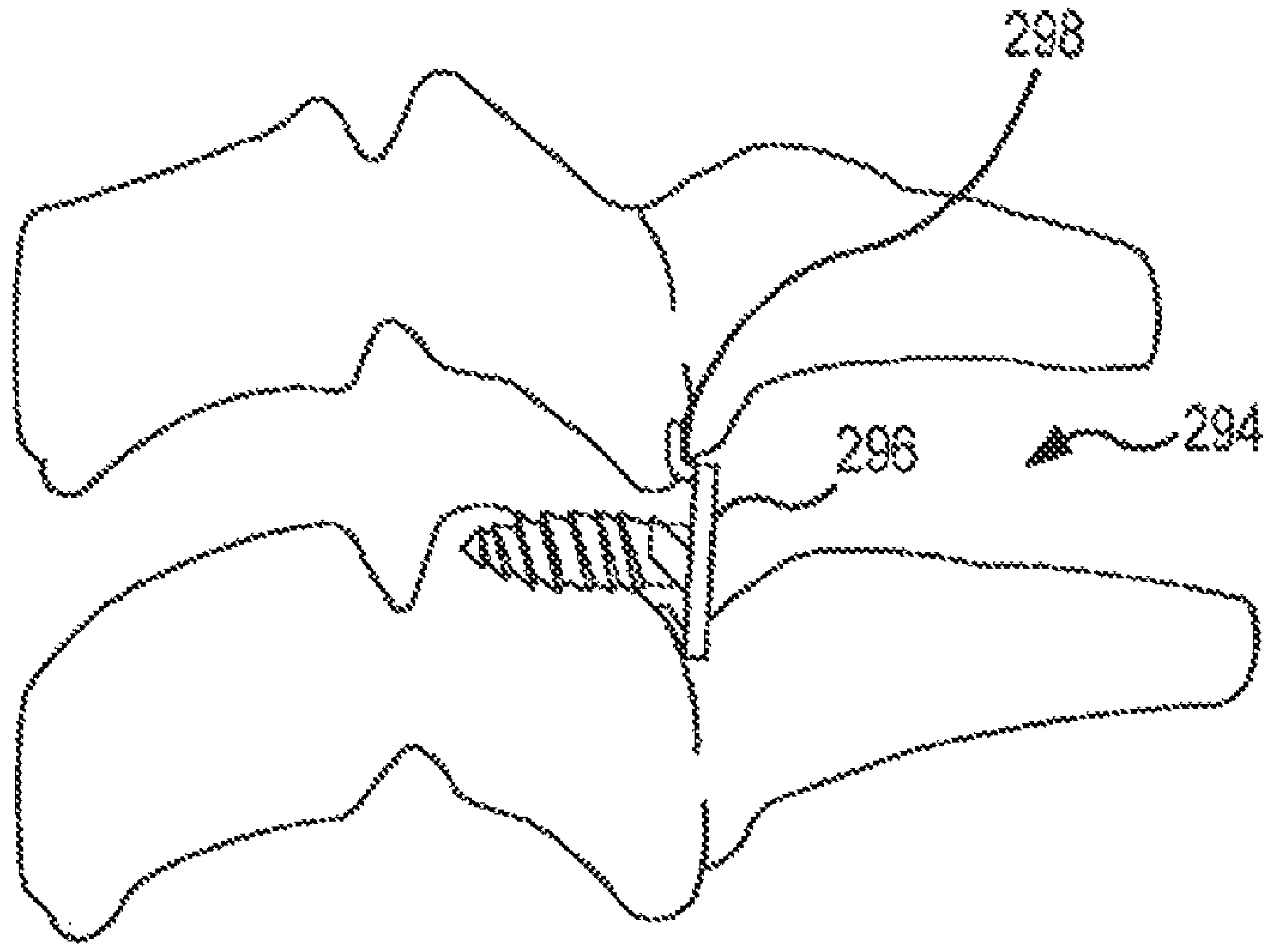


FIG.42E

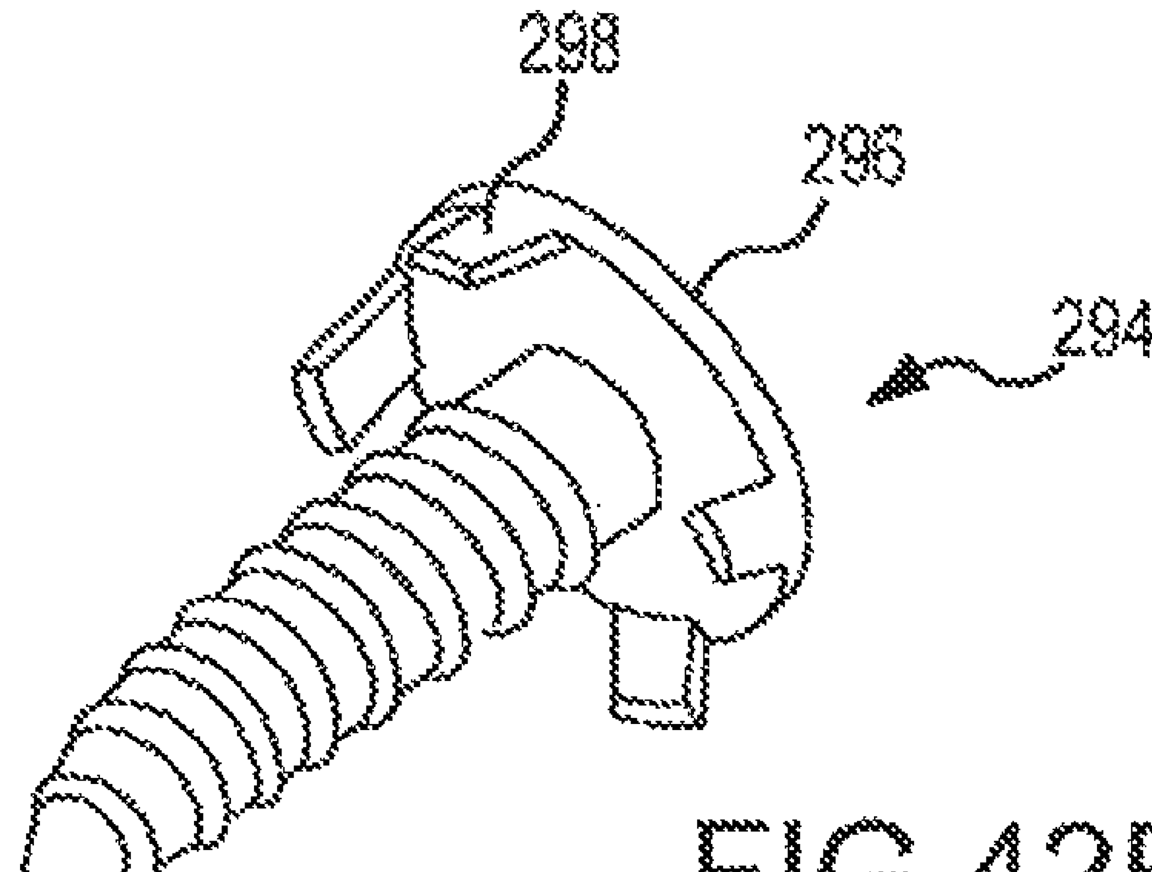


FIG.42F

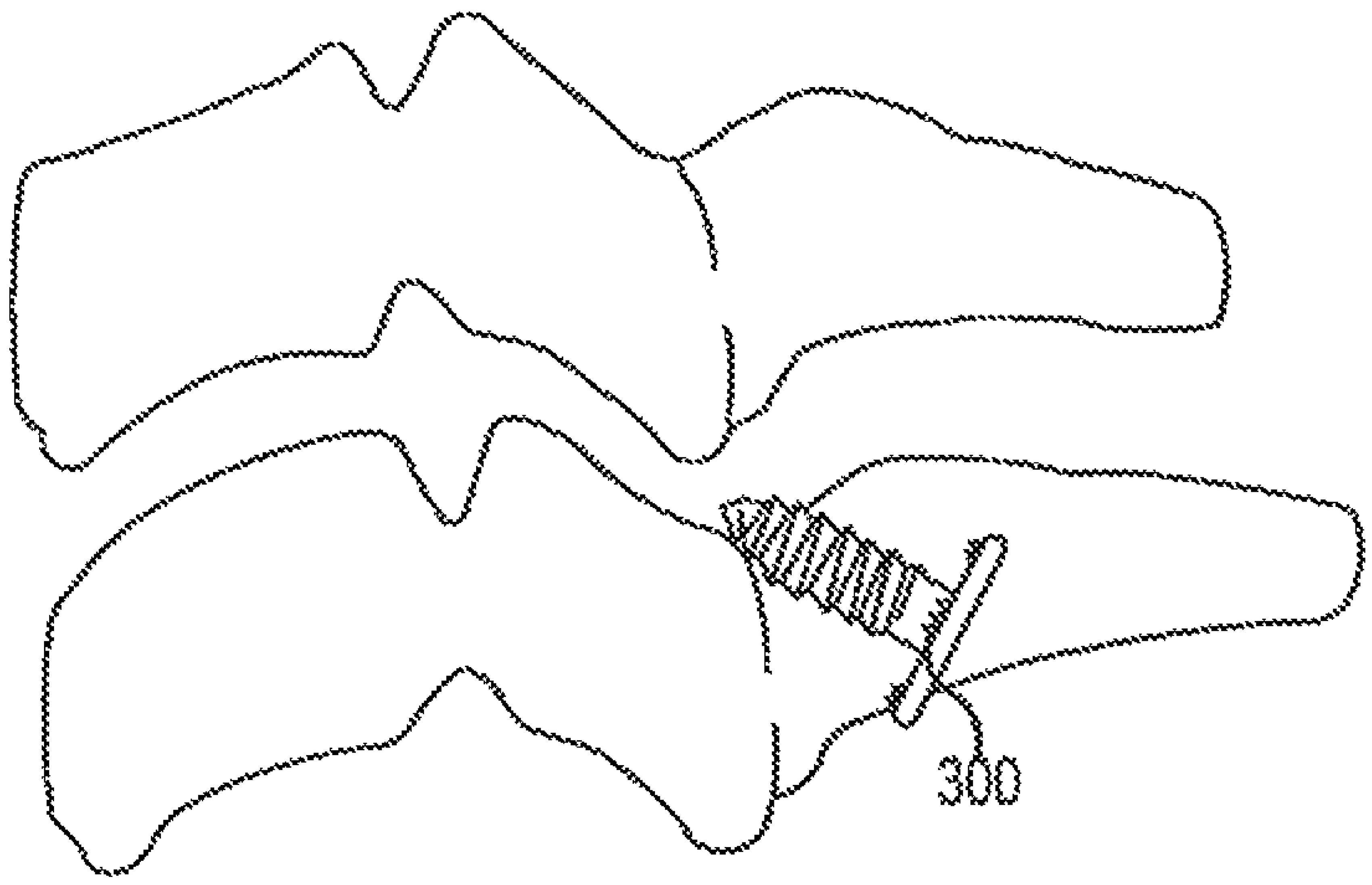


FIG.43A

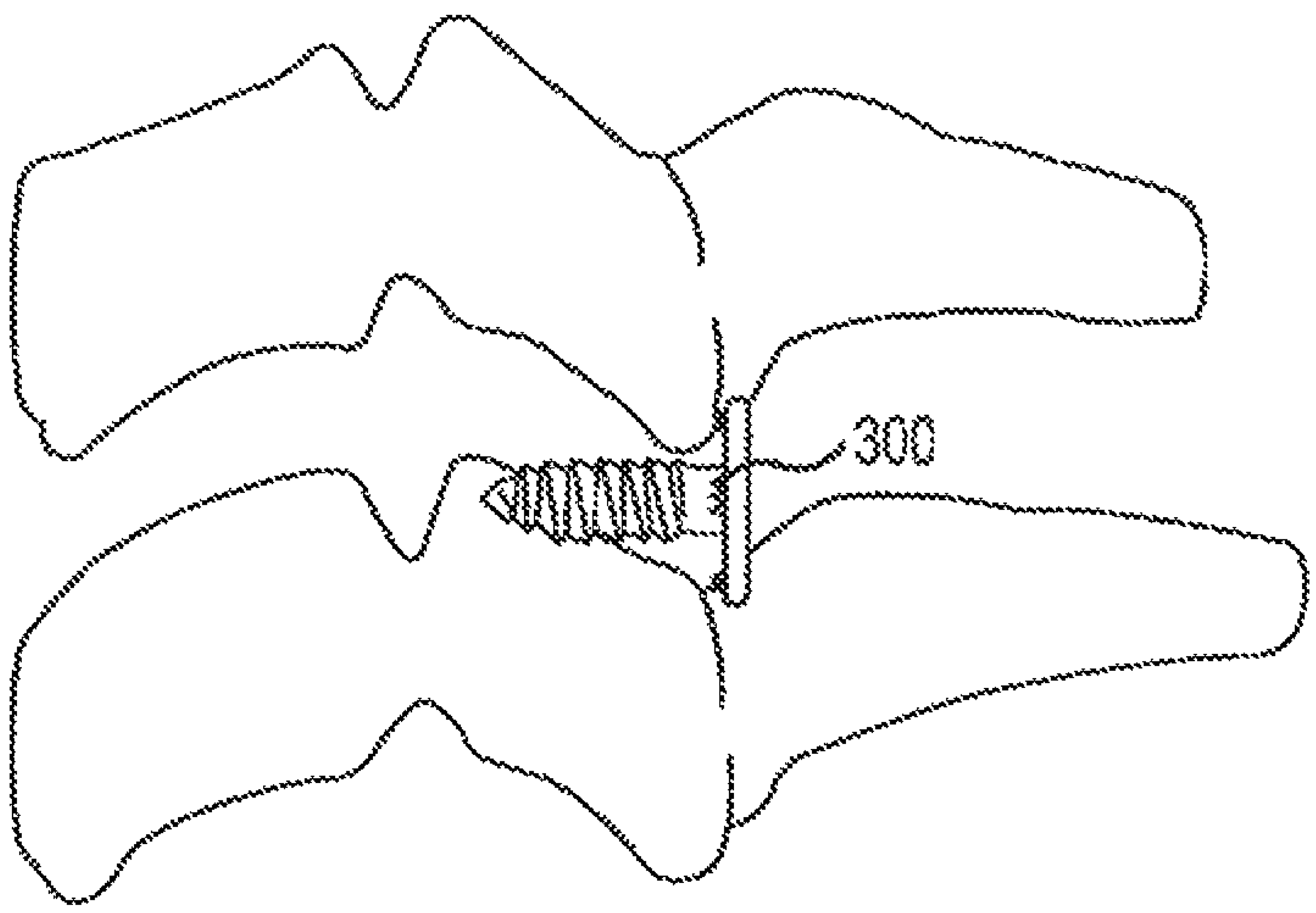


FIG.43B

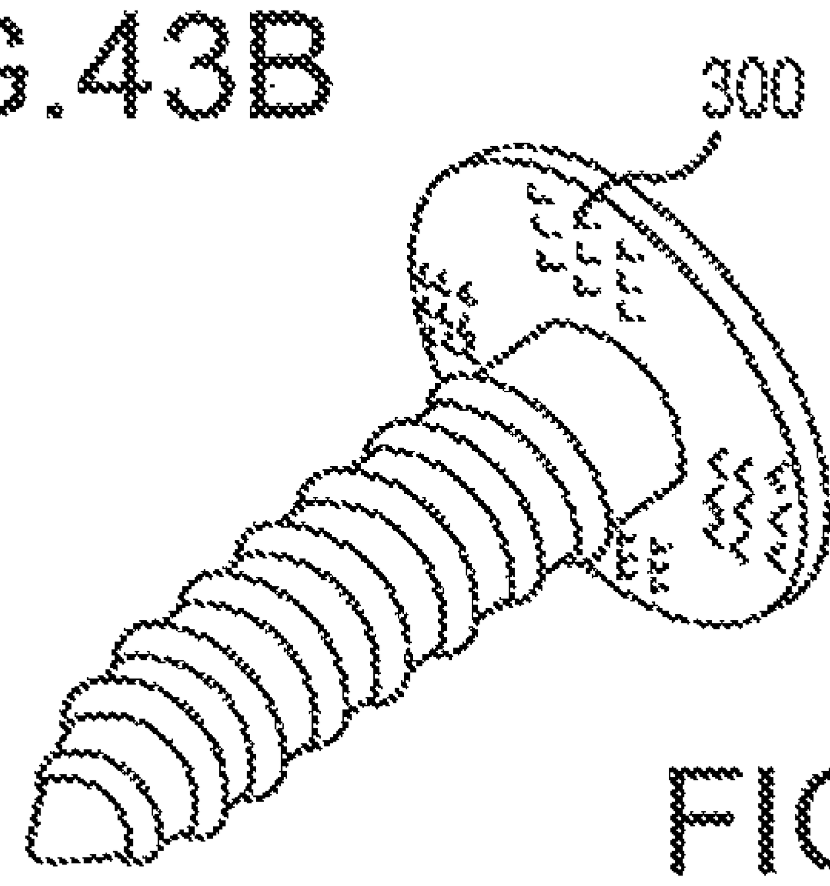


FIG.43C

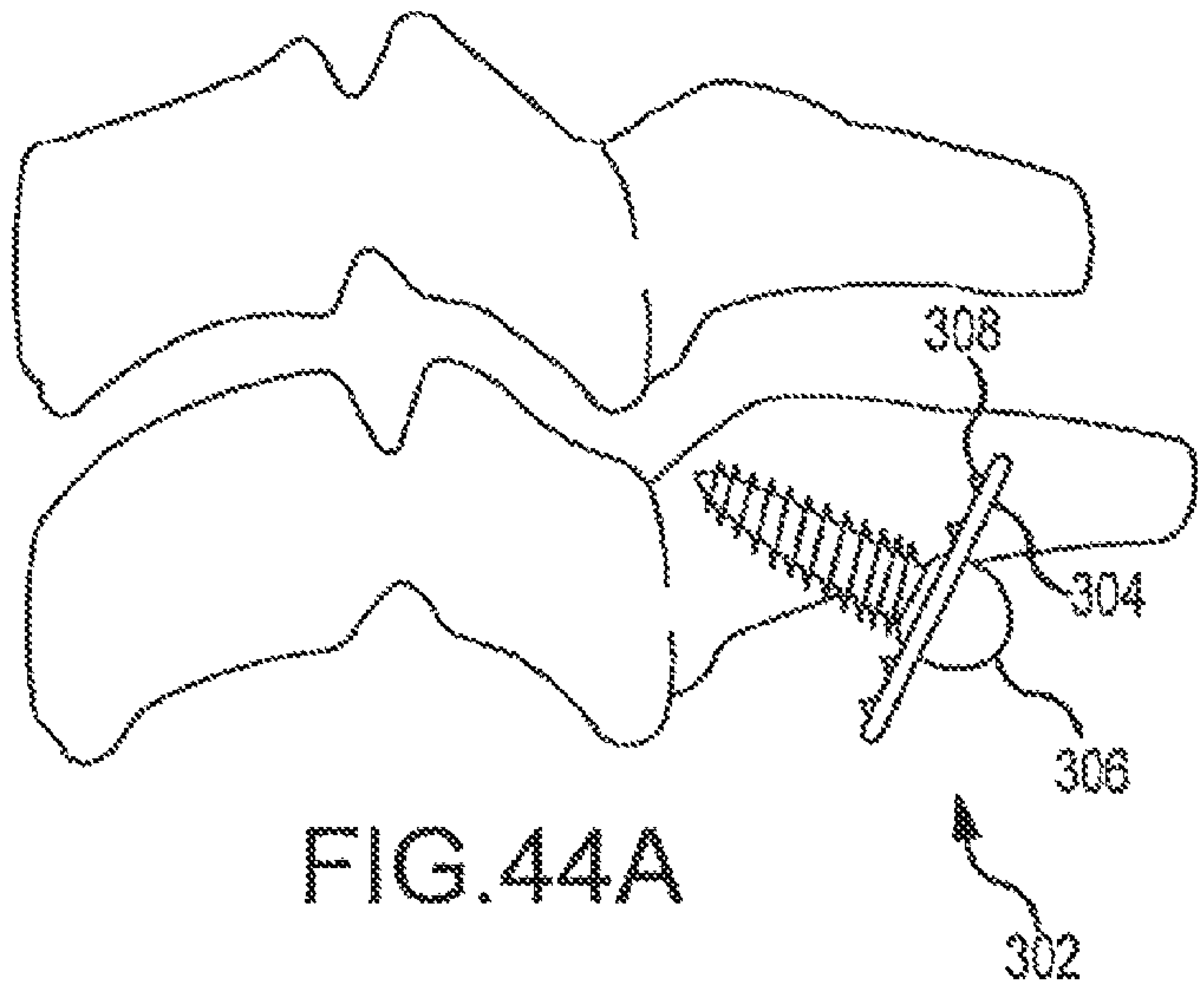


FIG.44A

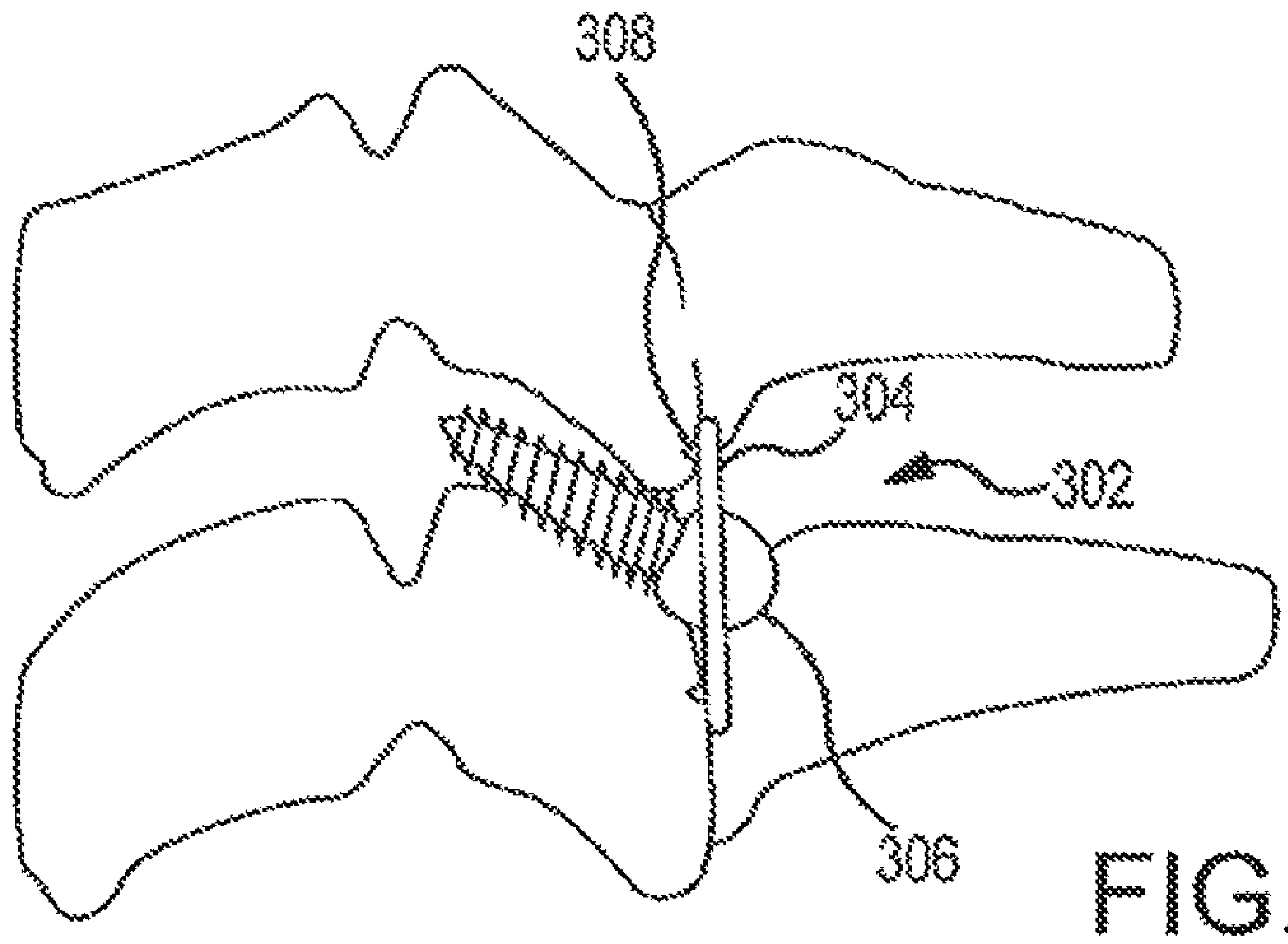


FIG.44B

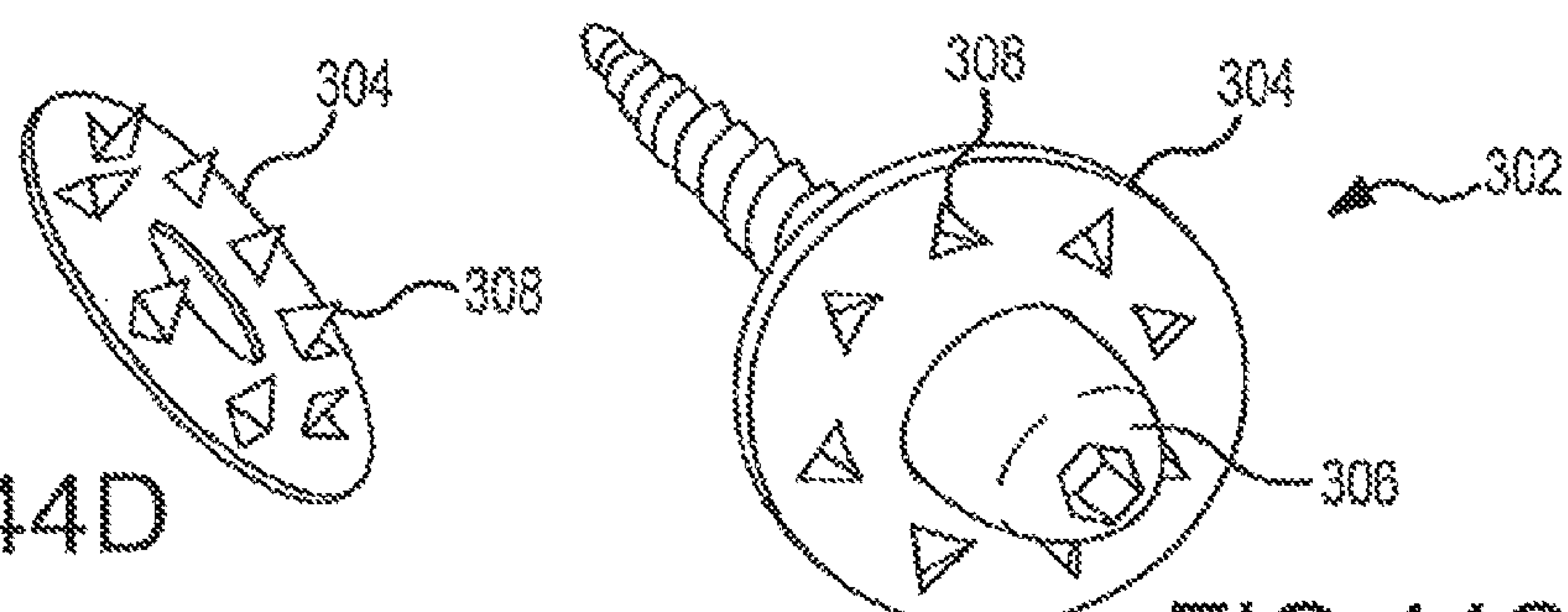


FIG.44D

FIG.44C

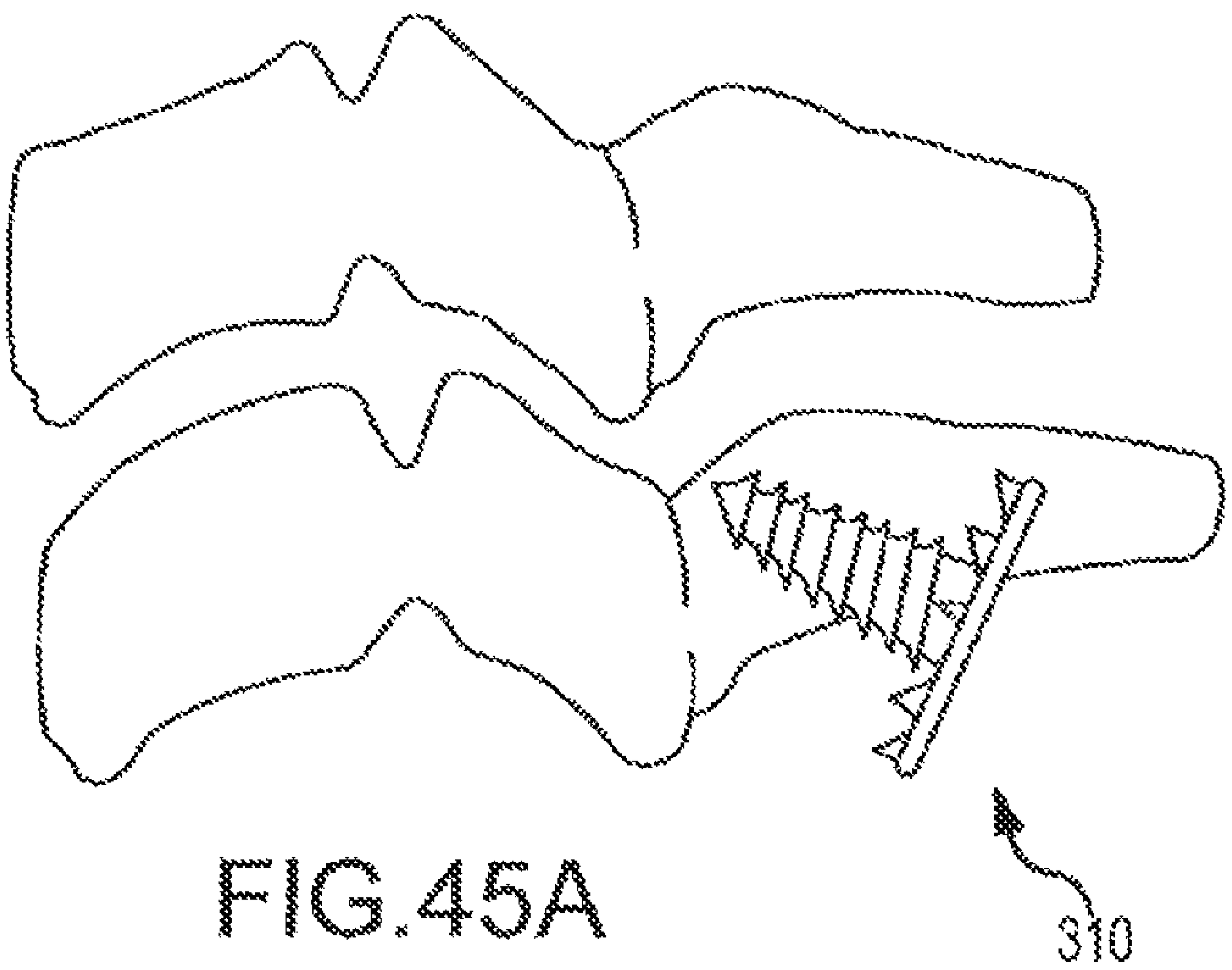


FIG.45A

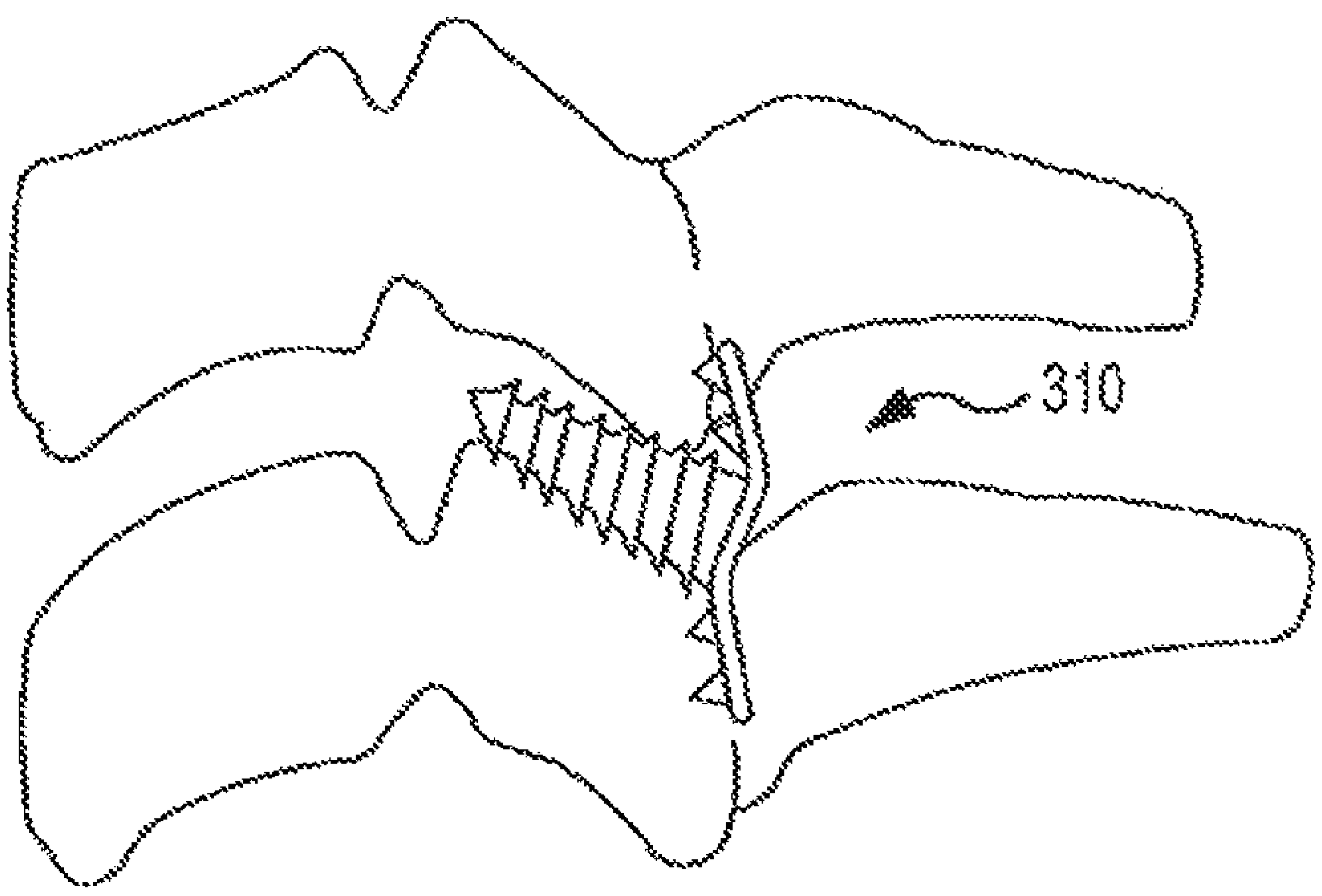


FIG.45B

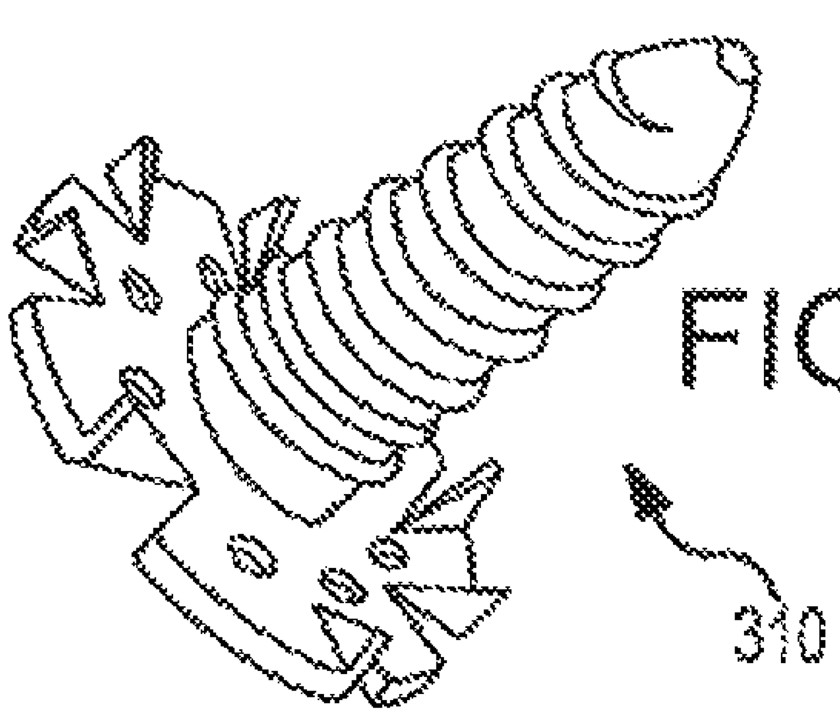


FIG.45C

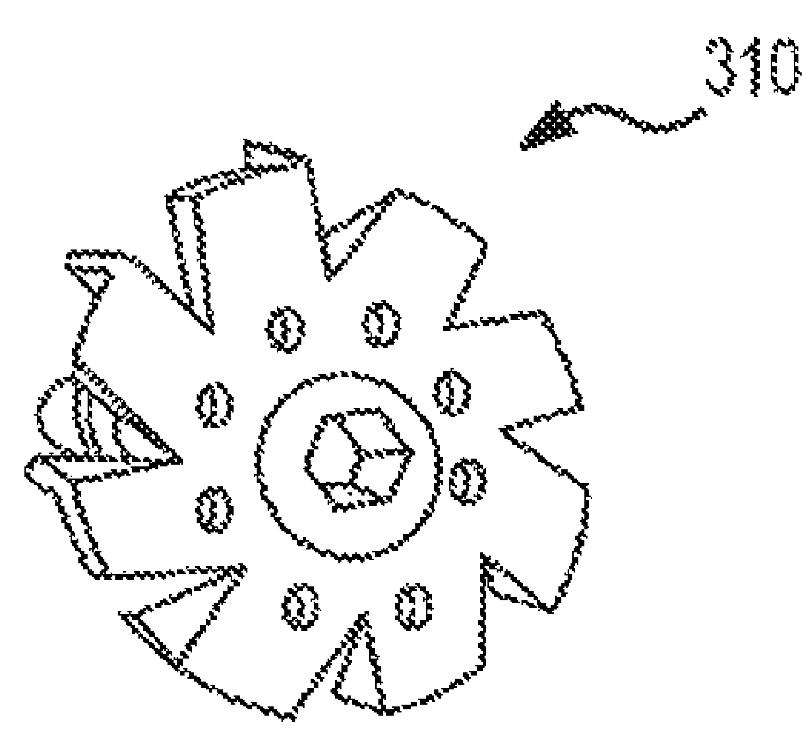


FIG.45D

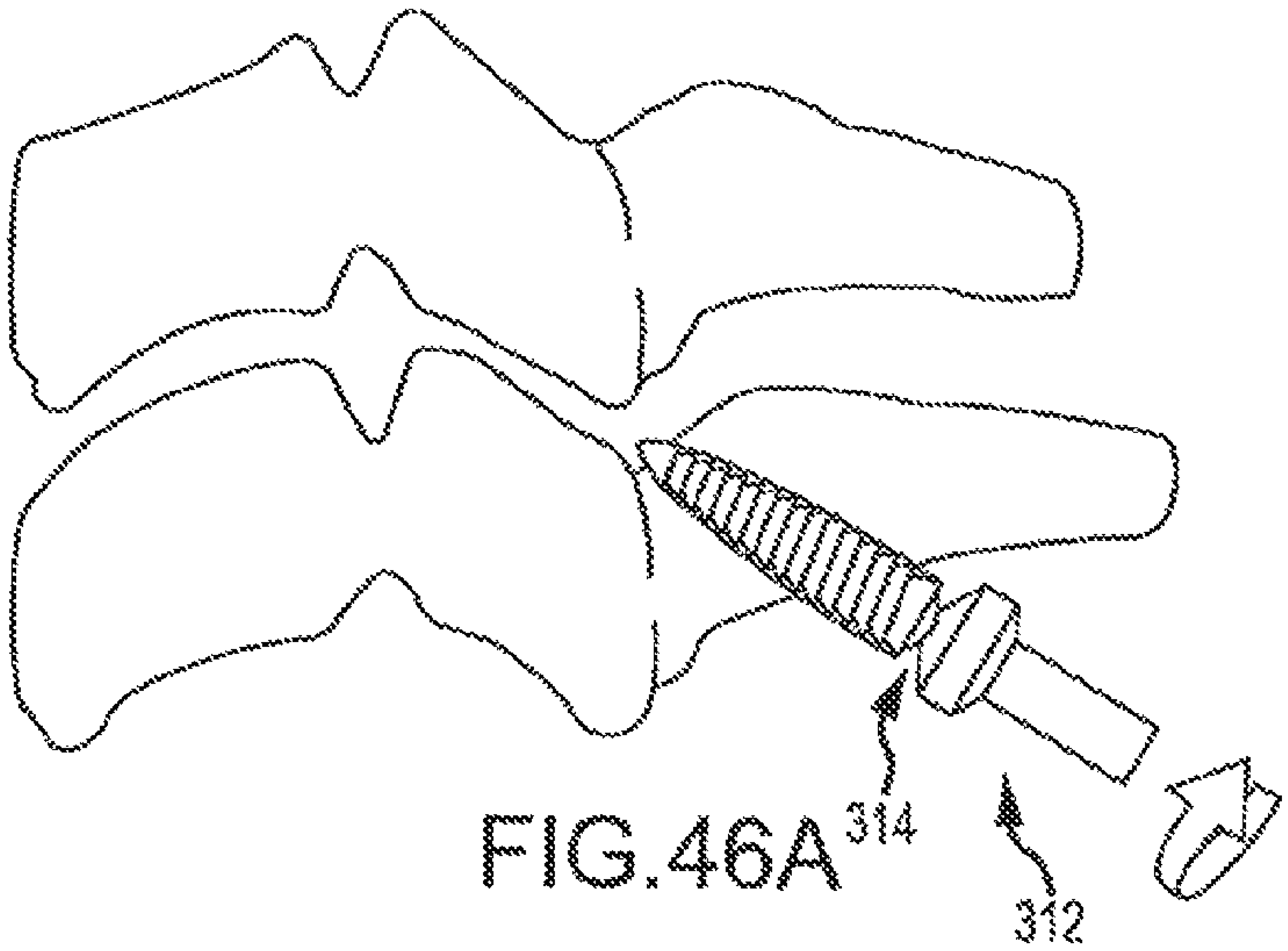


FIG.46A

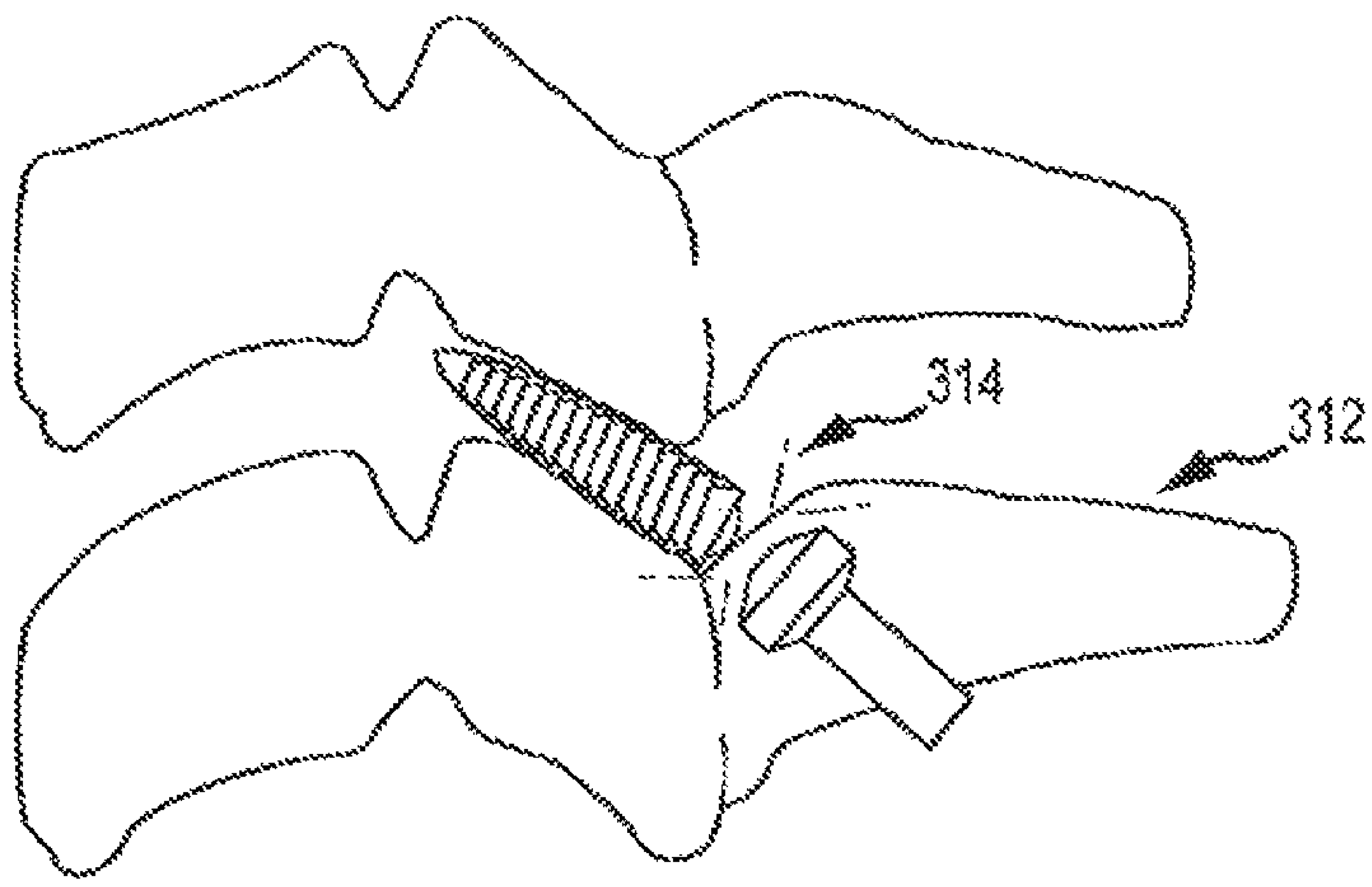


FIG.46B

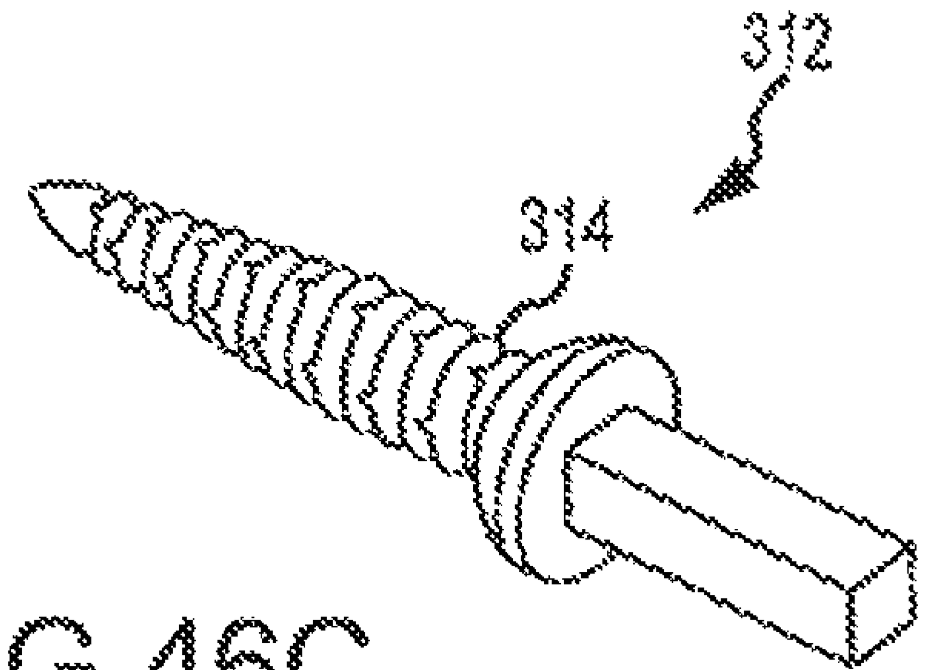


FIG.46C

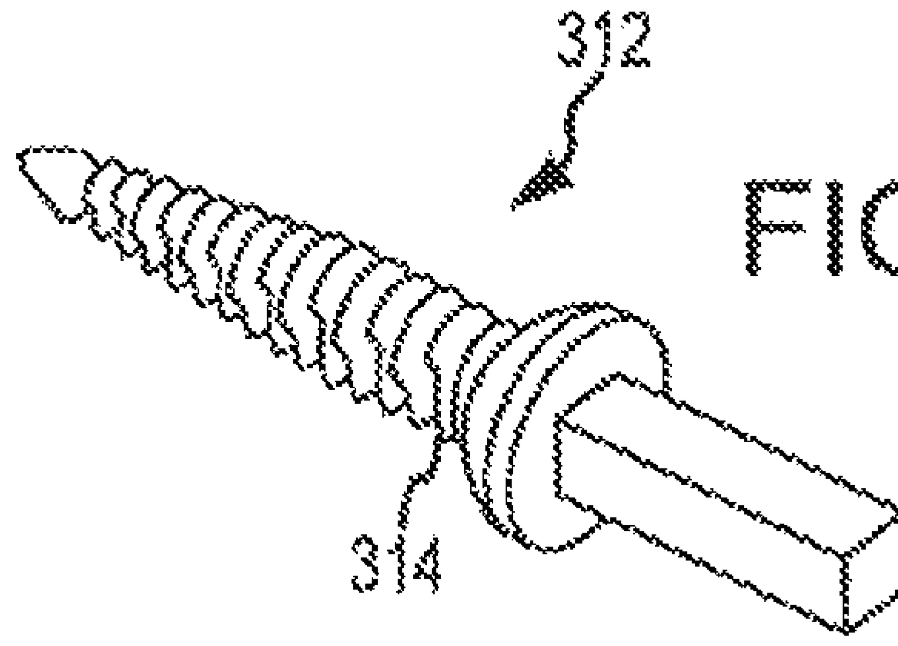


FIG.46D

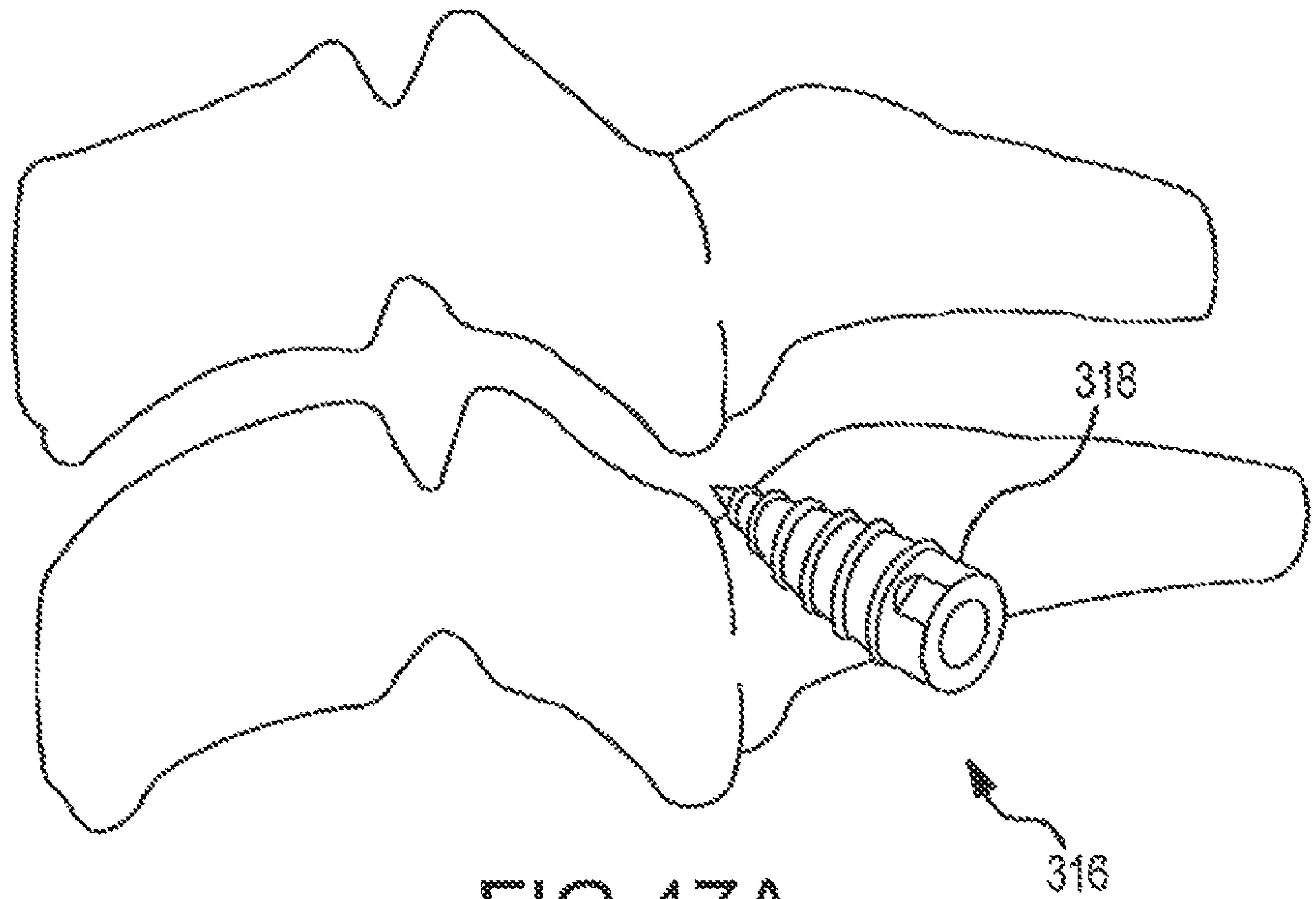


FIG.47A

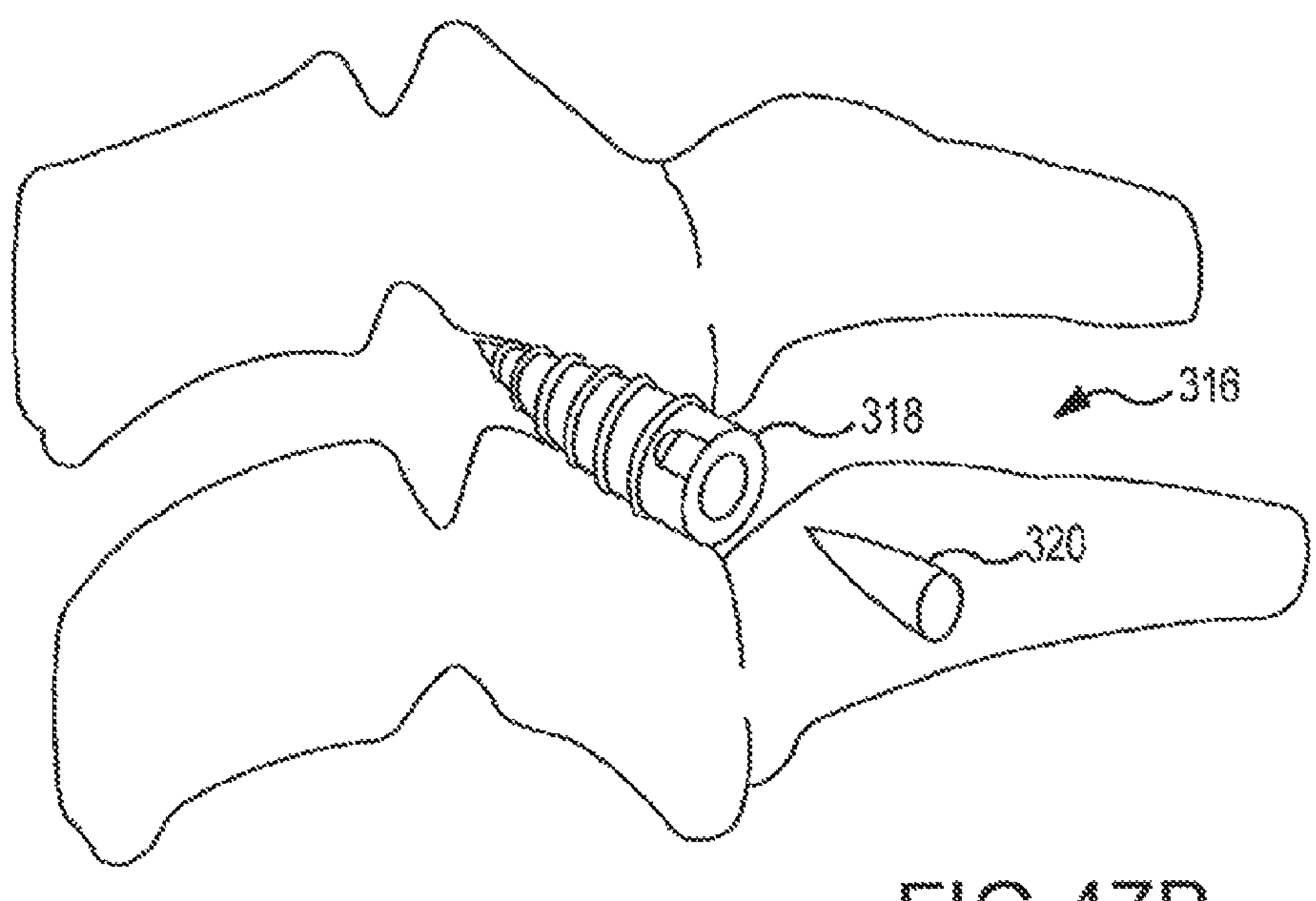


FIG.47B

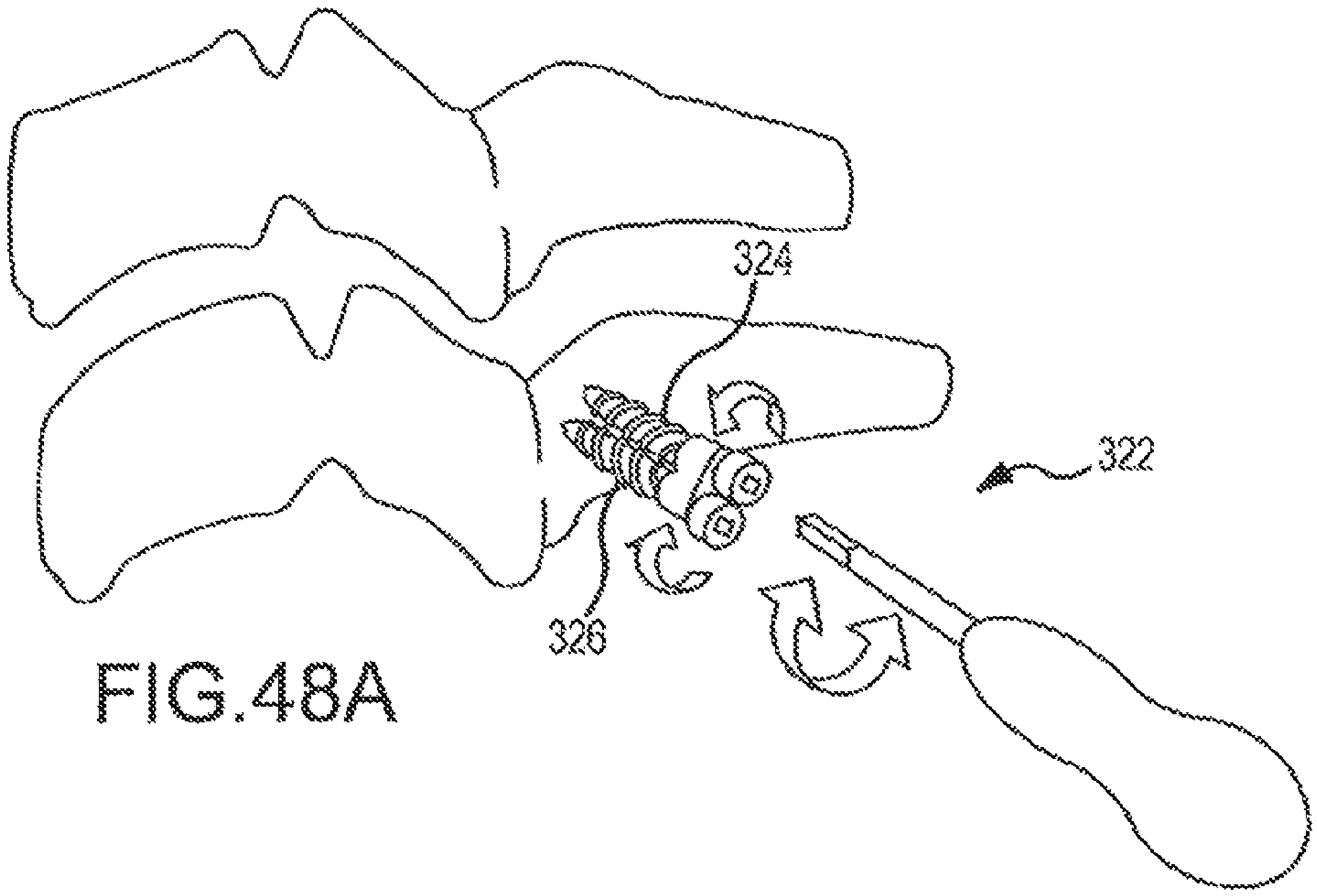


FIG.48A

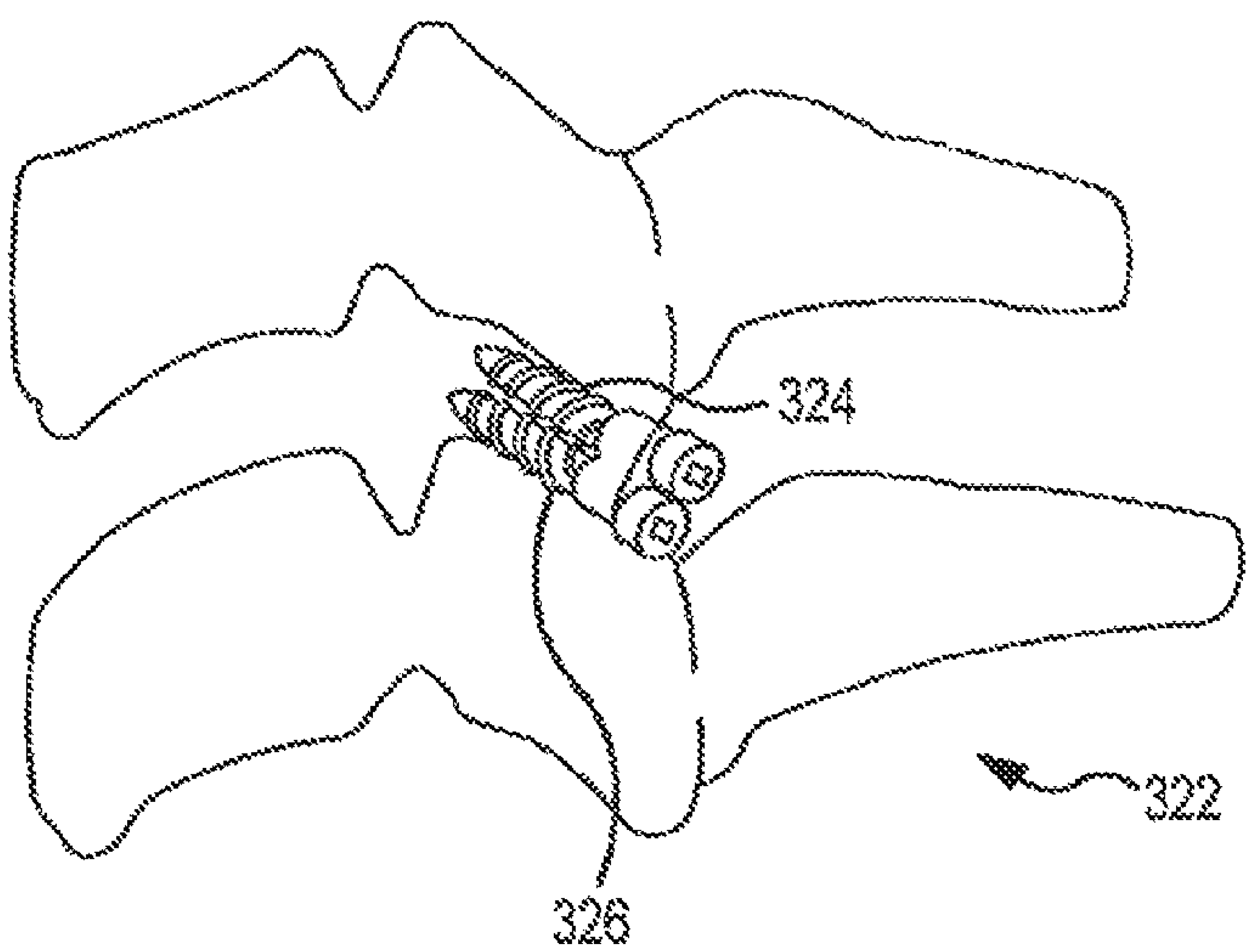


FIG.48B

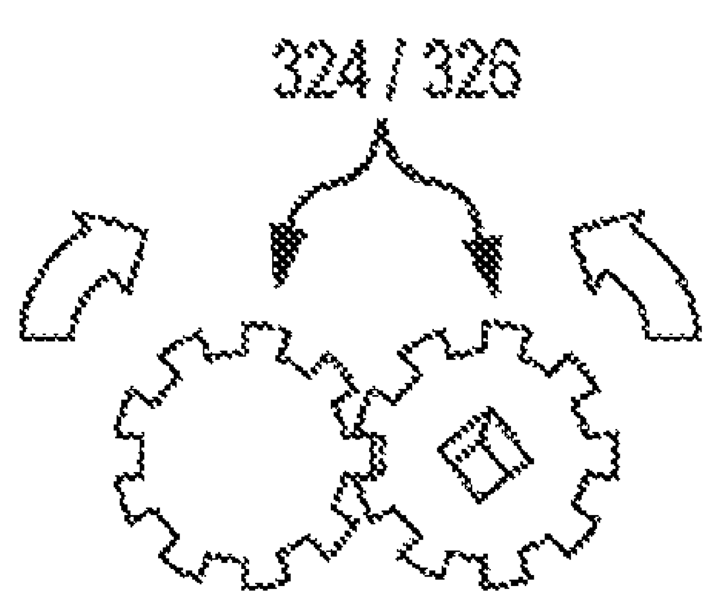


FIG.48C

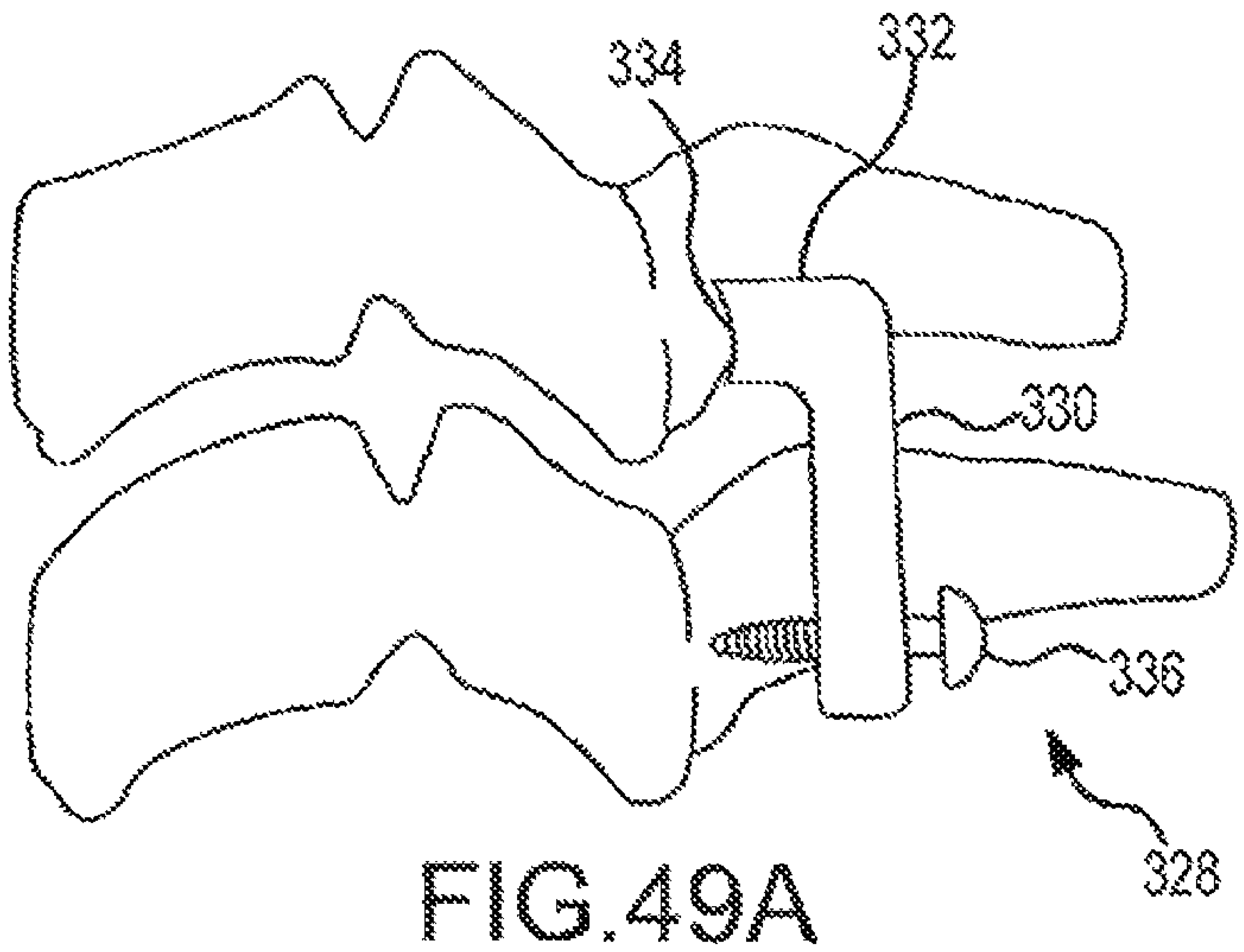


FIG.49A

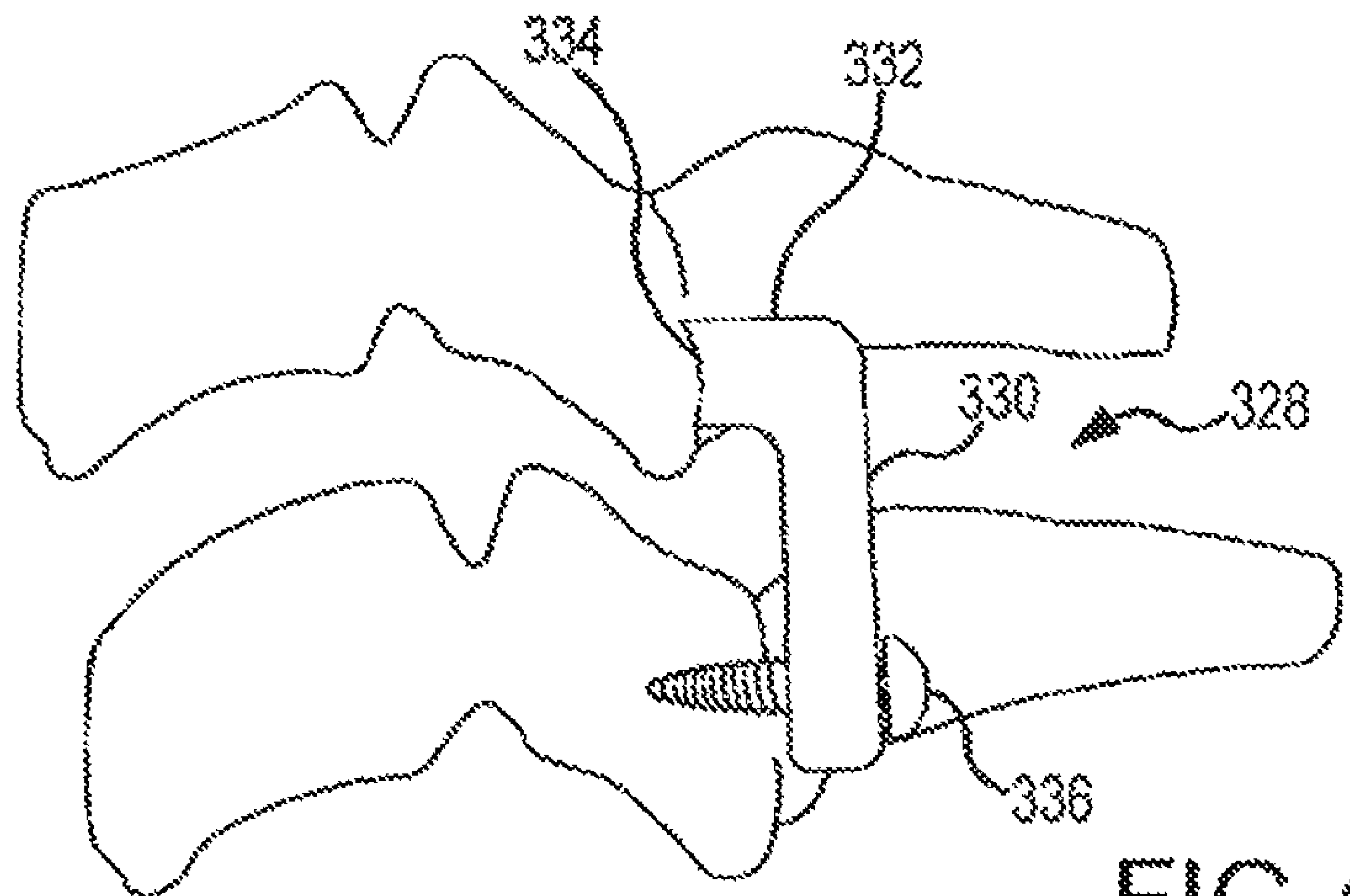


FIG.49B

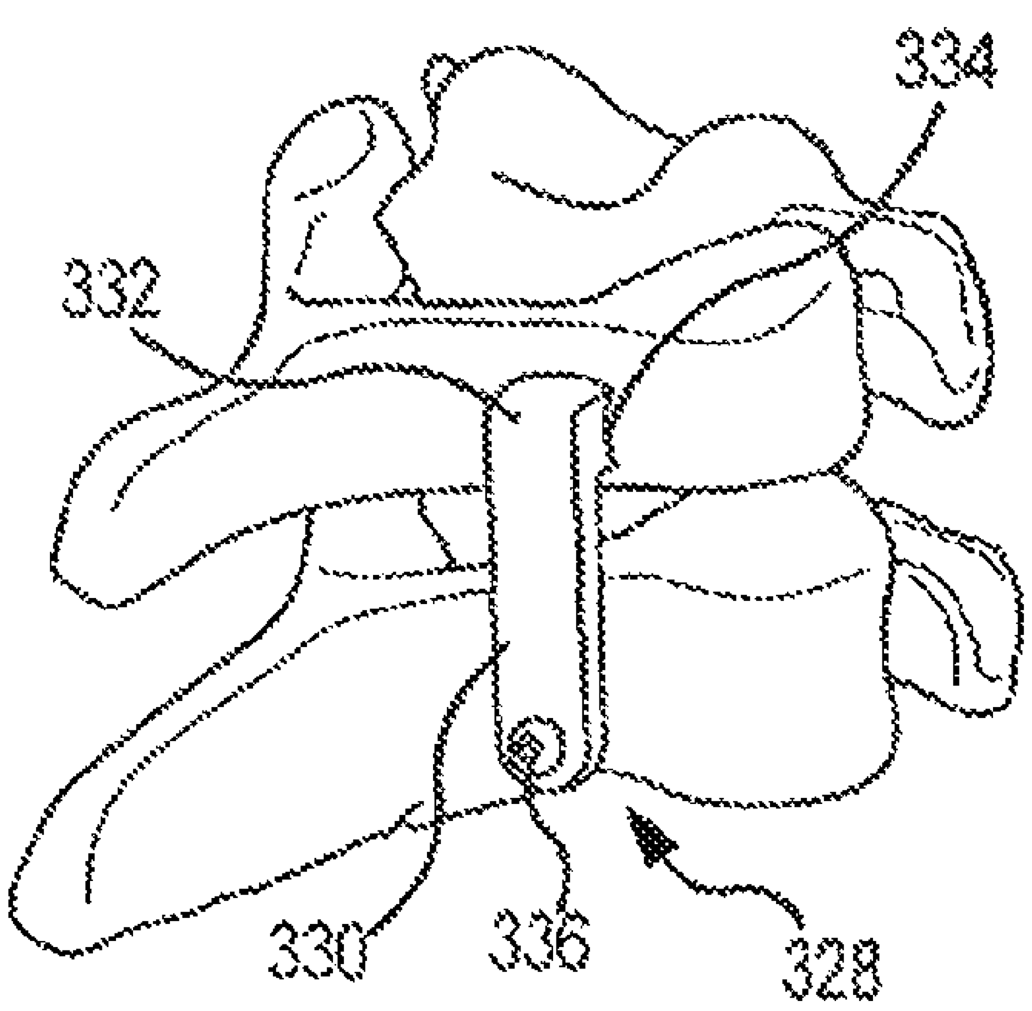


FIG.49C

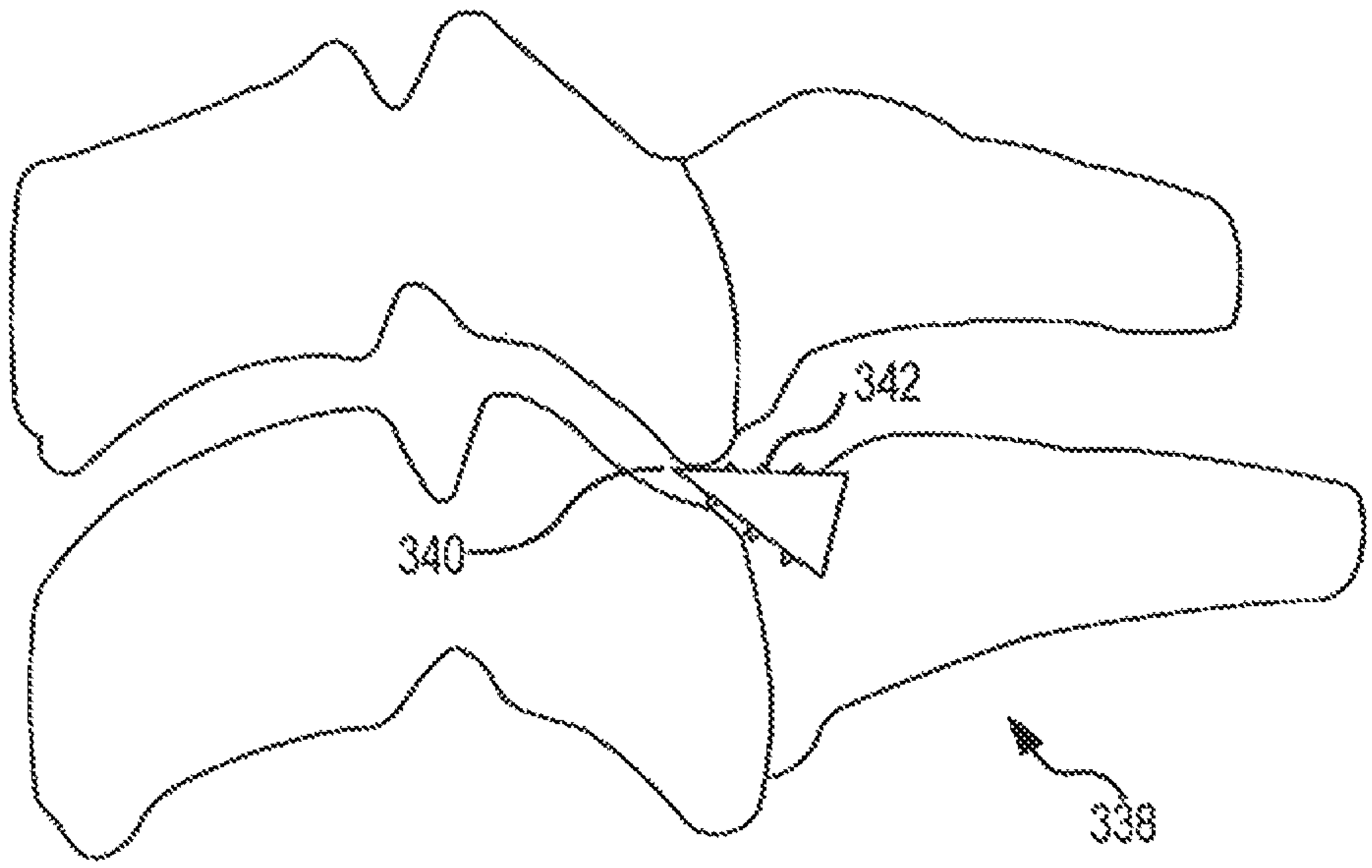


FIG.50A

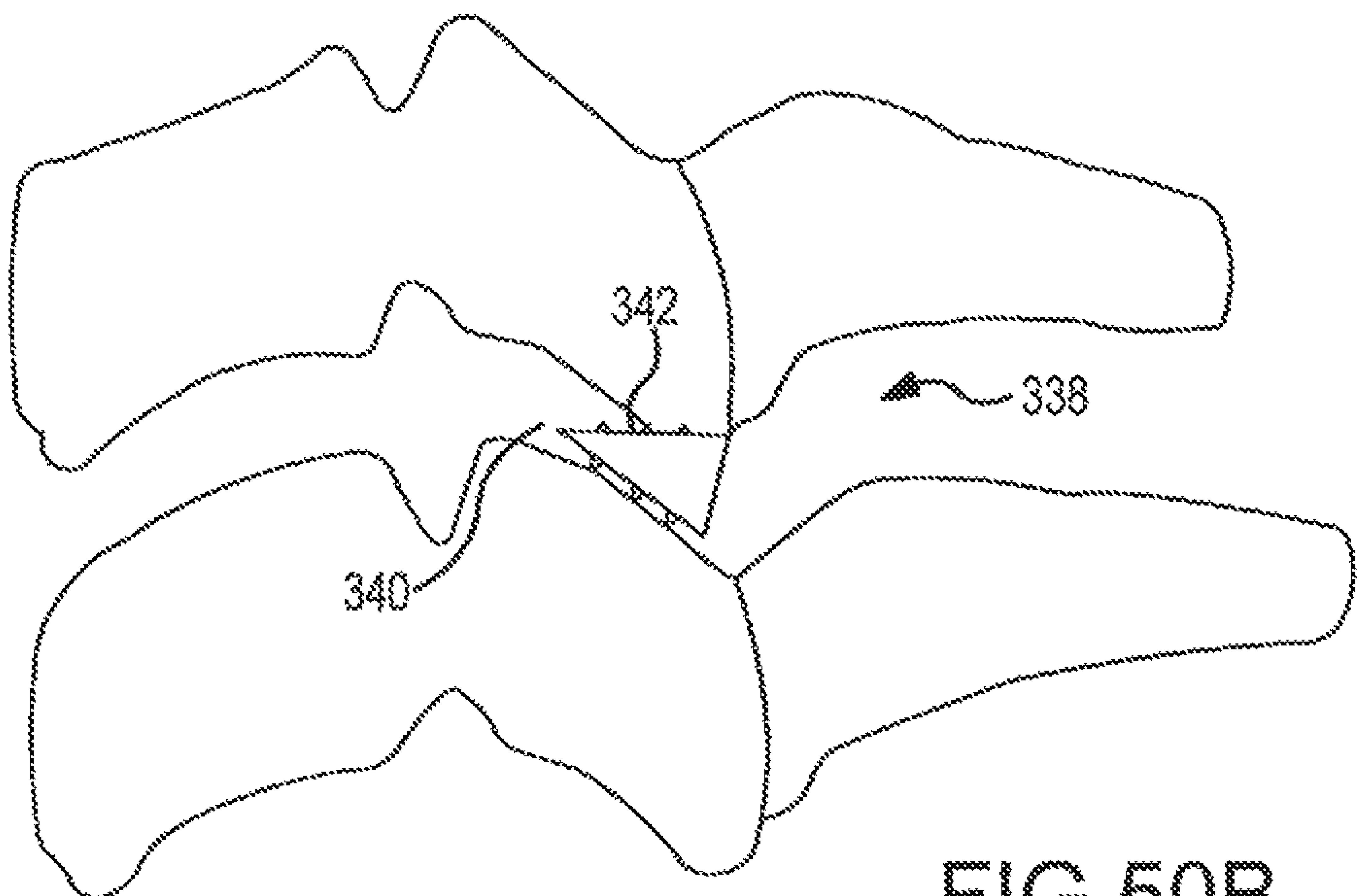


FIG.50B

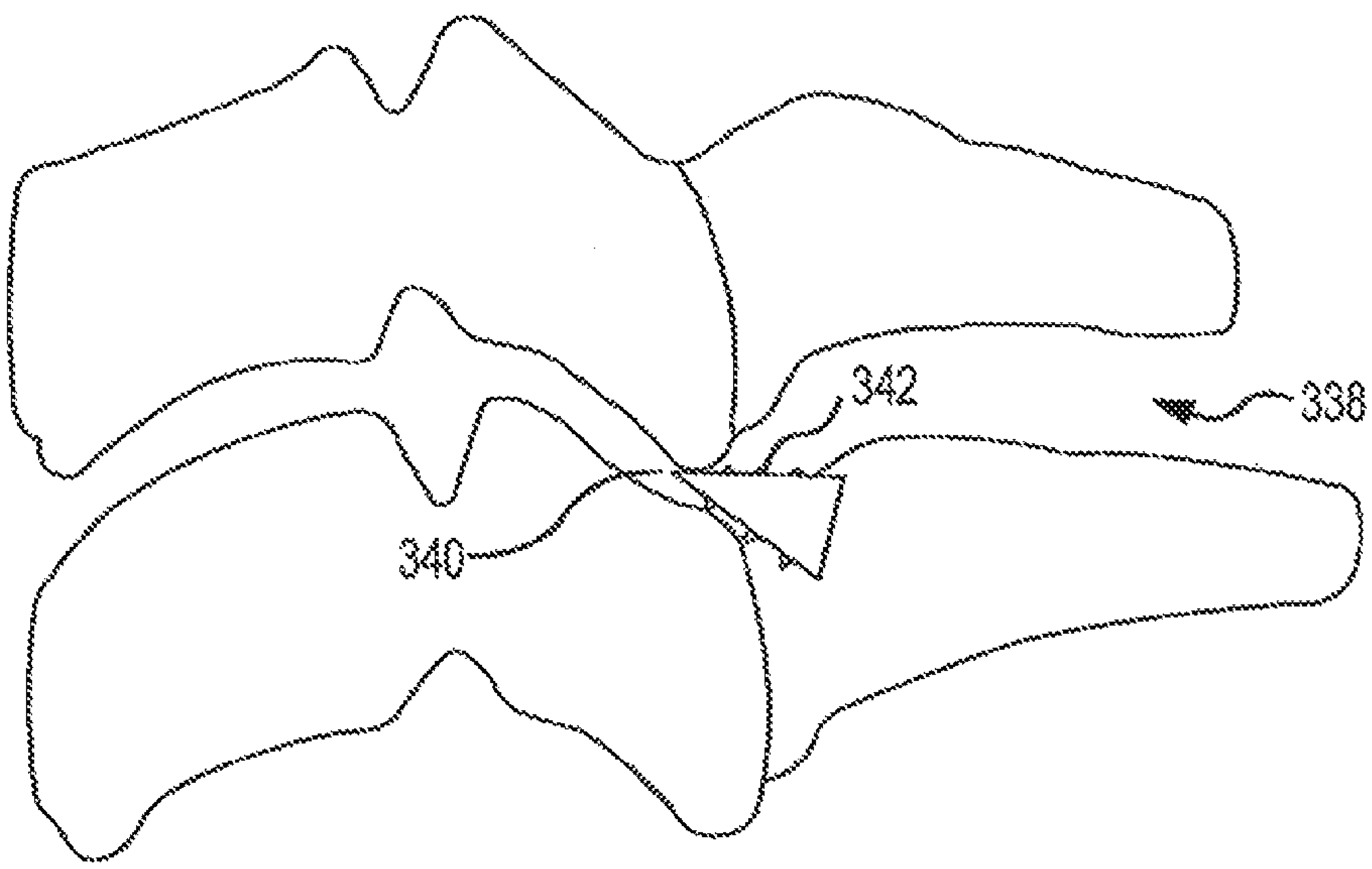


FIG.51A

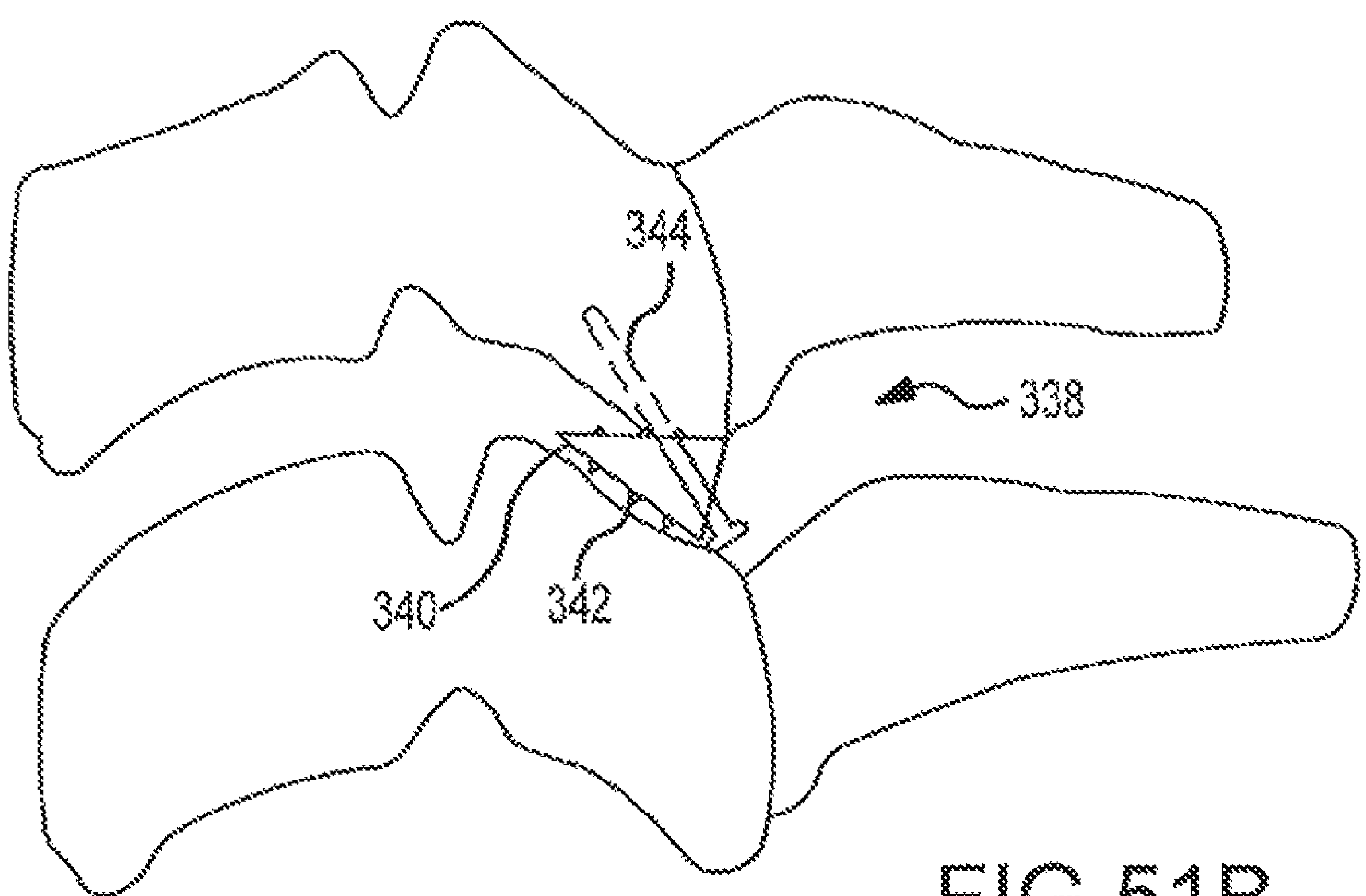


FIG.51B

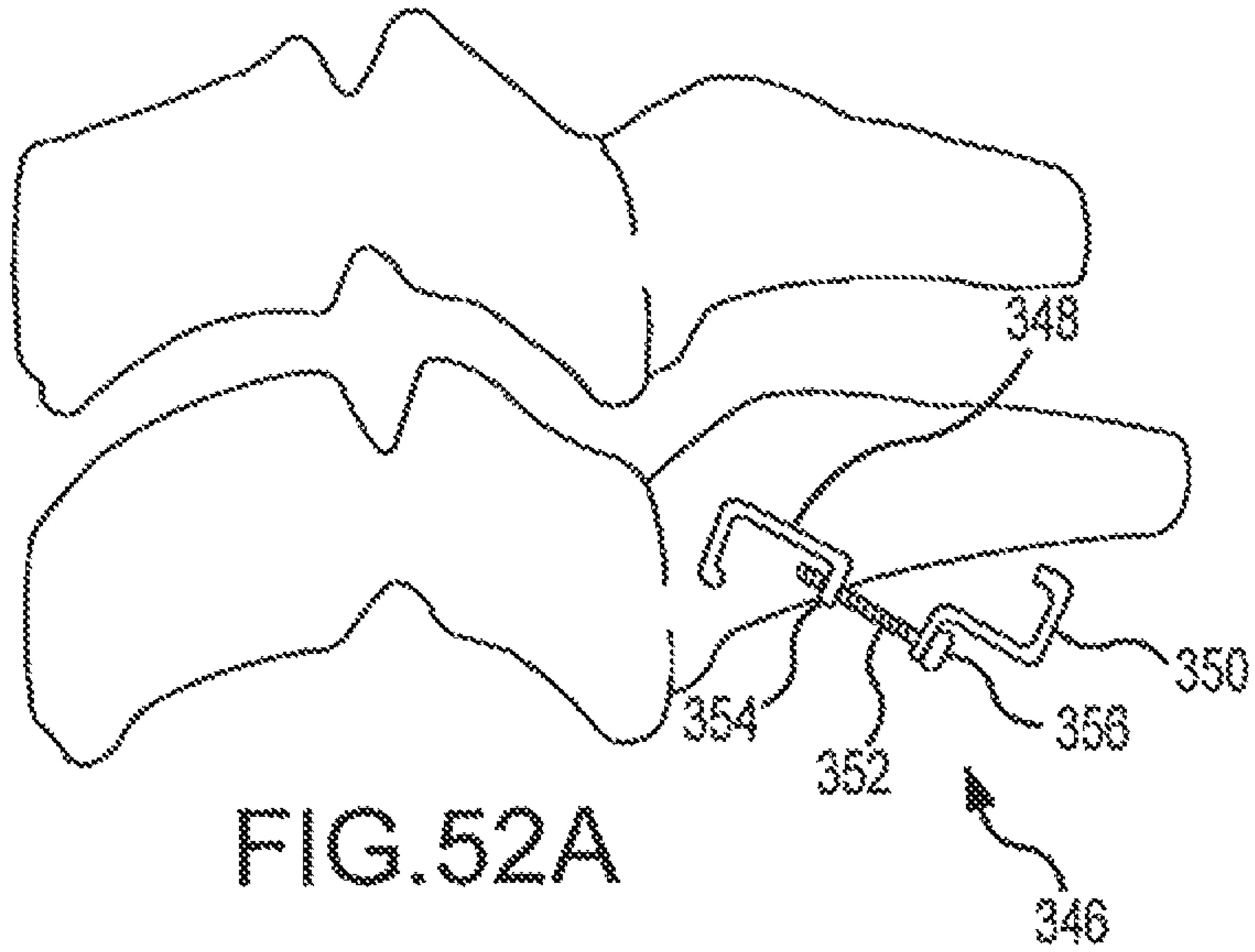


FIG.52A

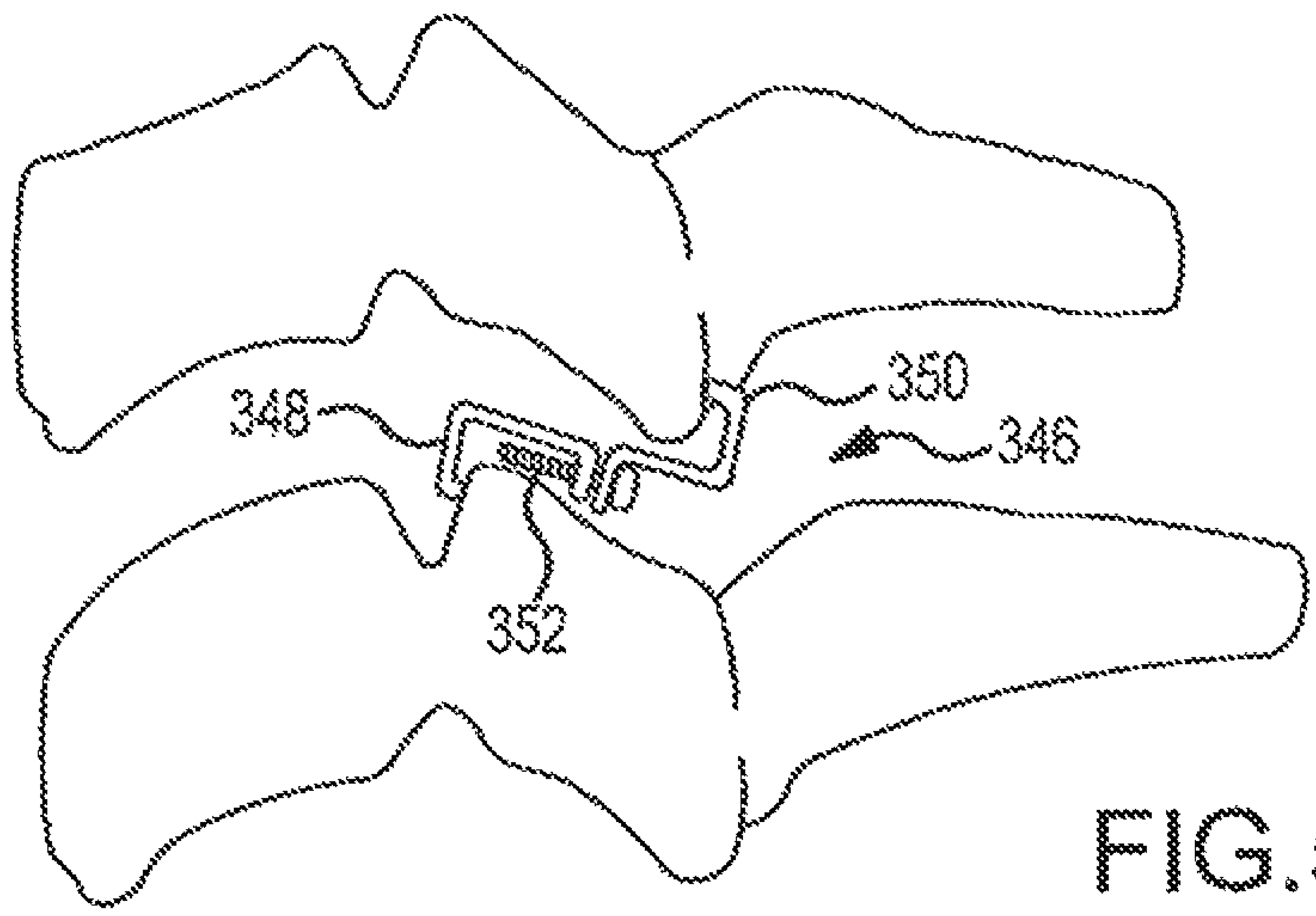


FIG.52B

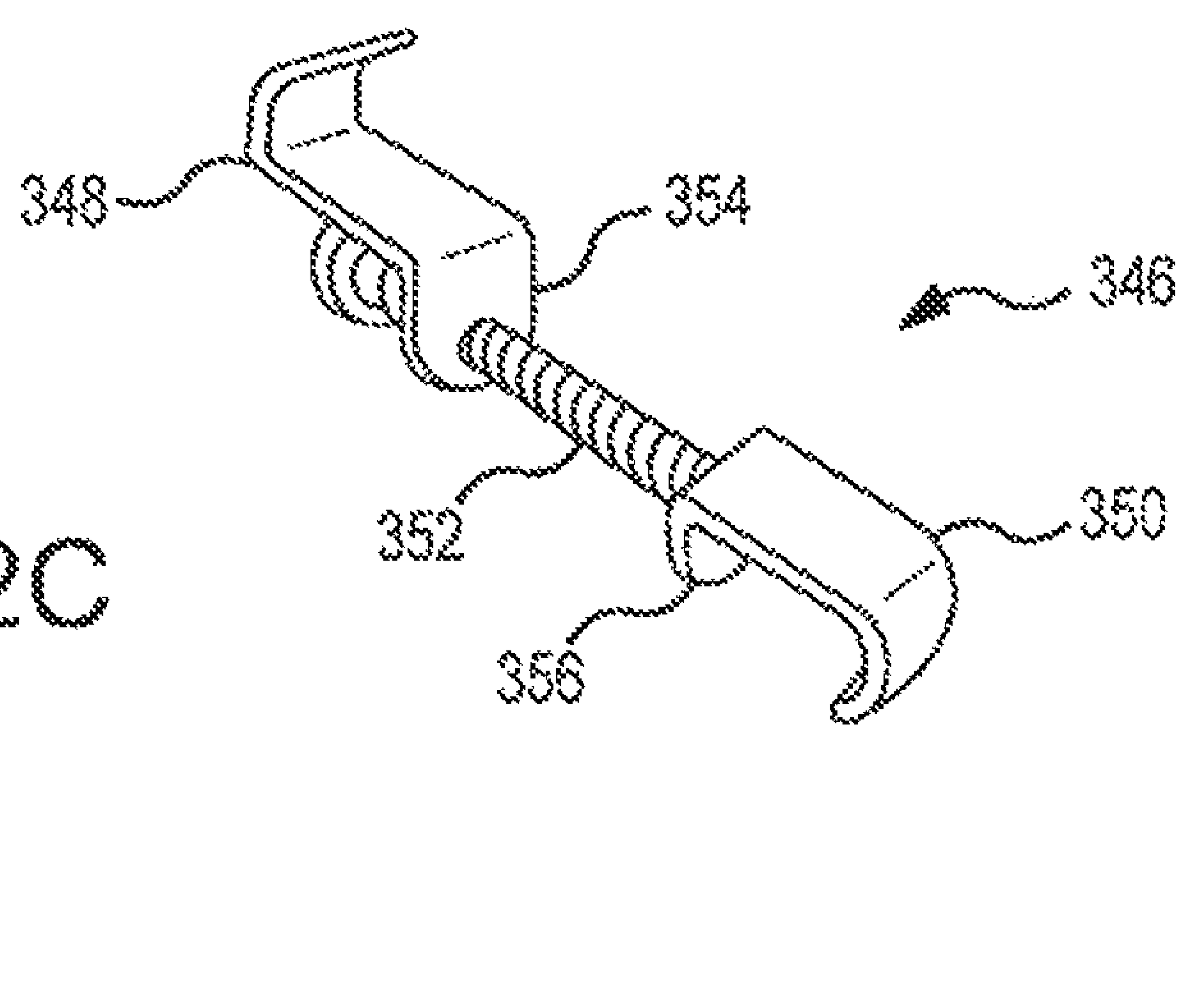


FIG.52C

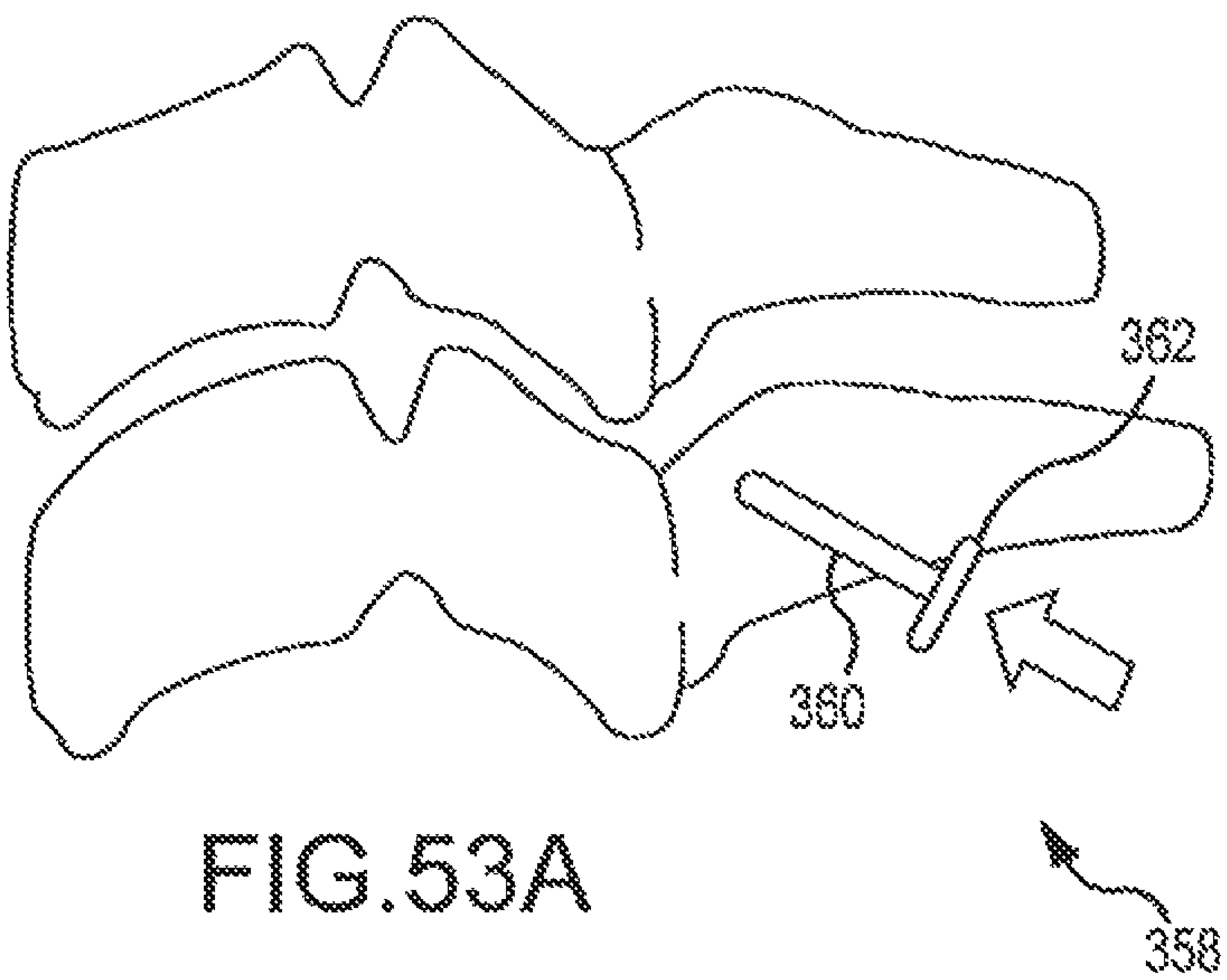


FIG.53A

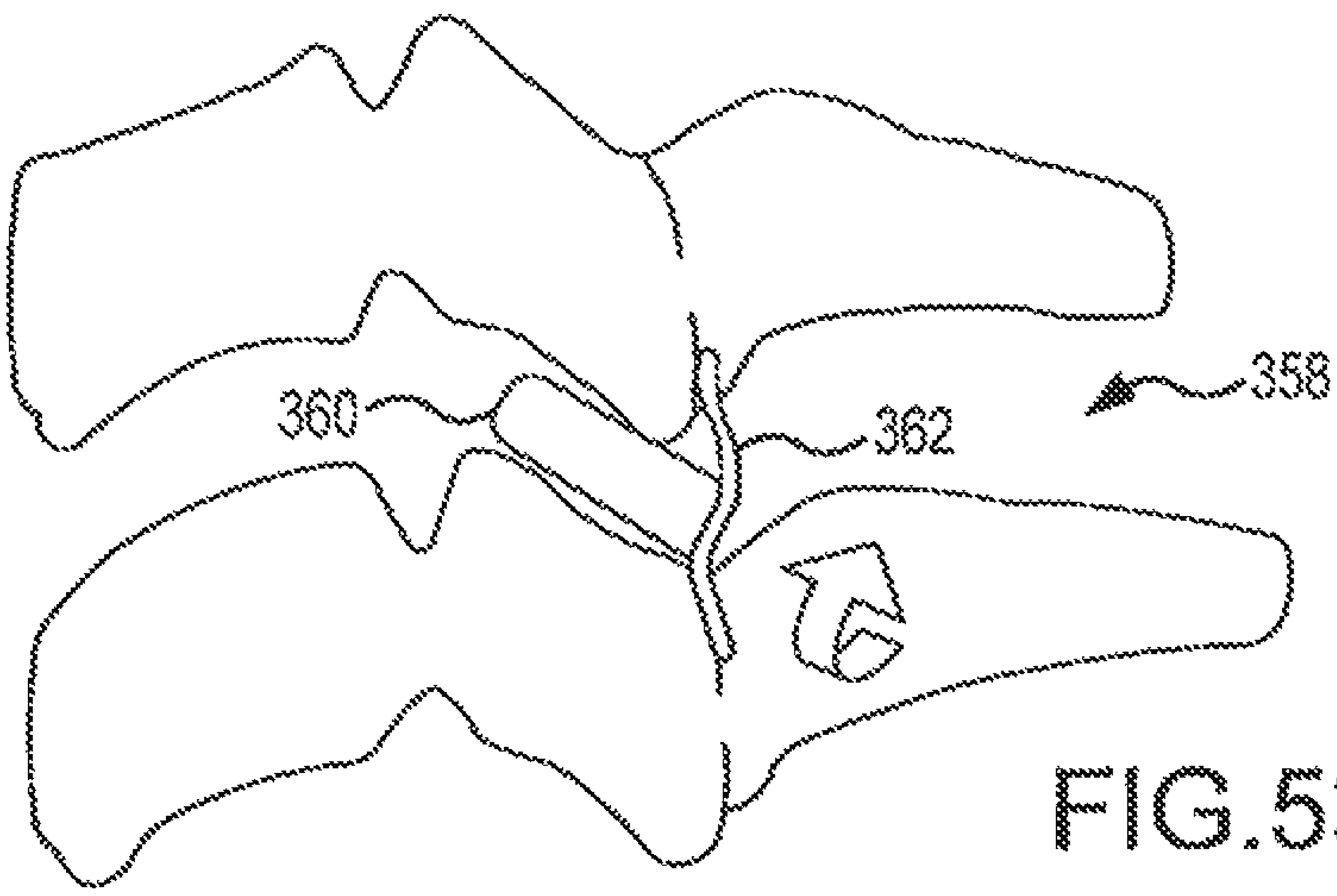


FIG.53B

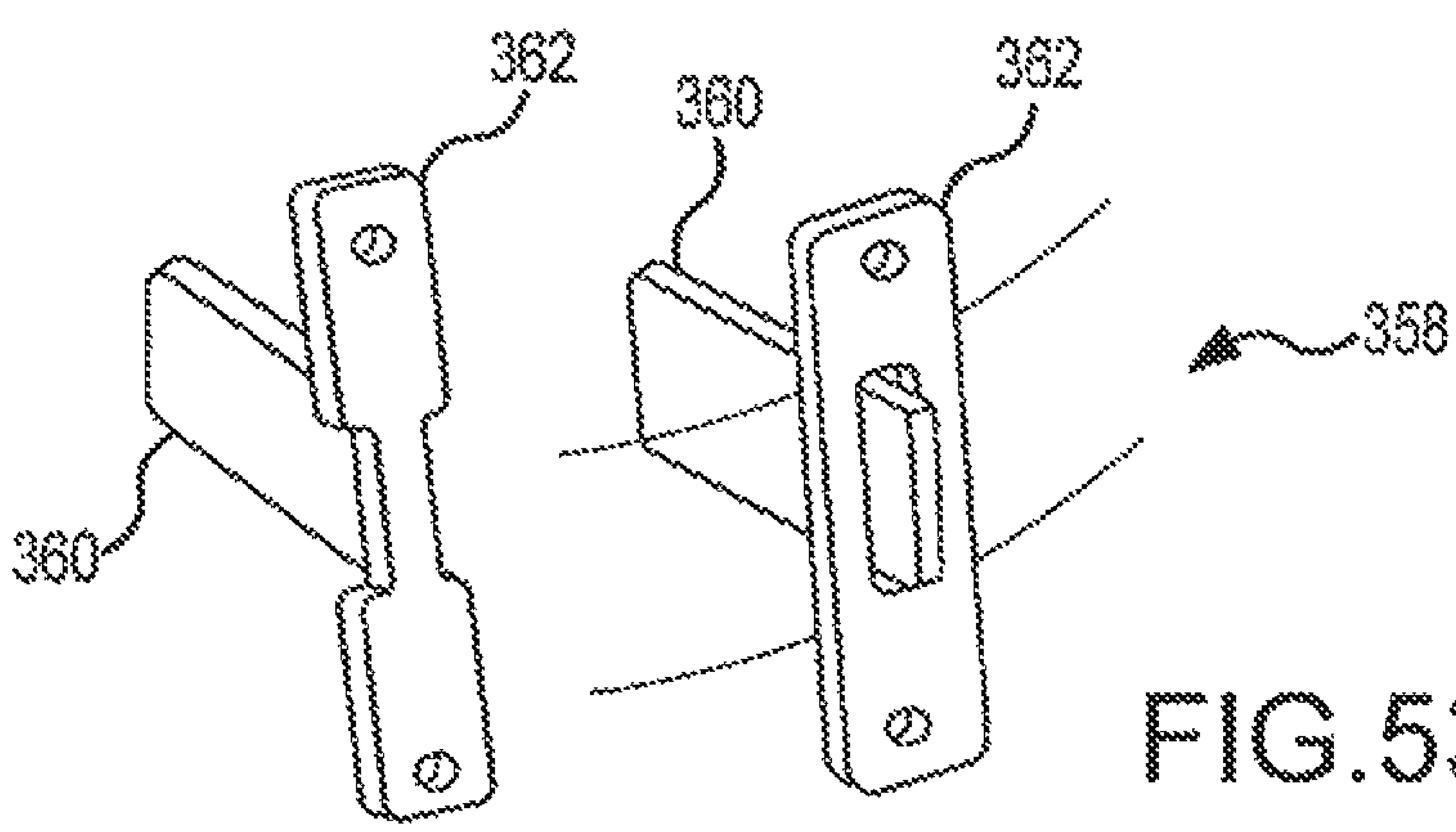


FIG.53C

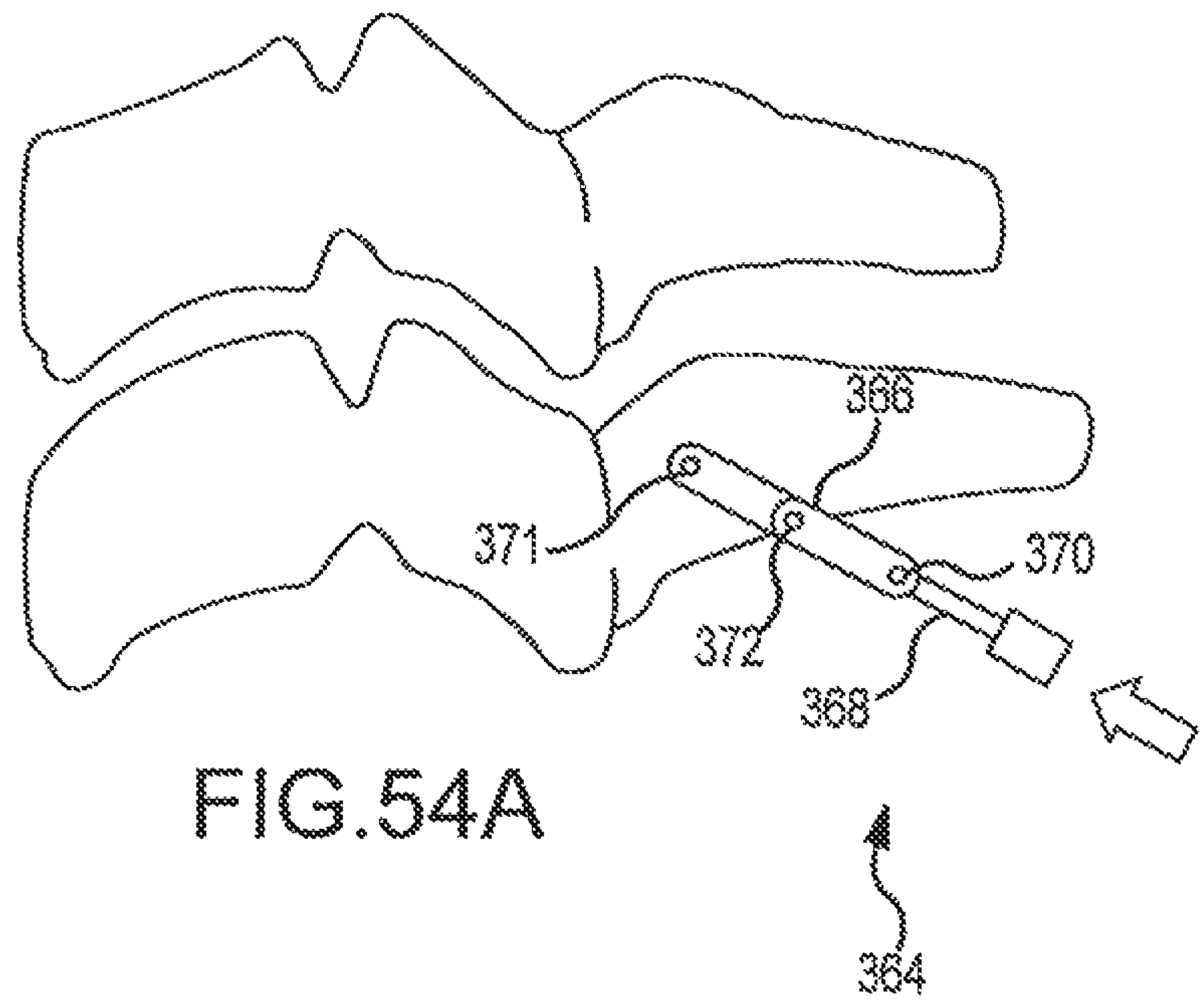


FIG.54A

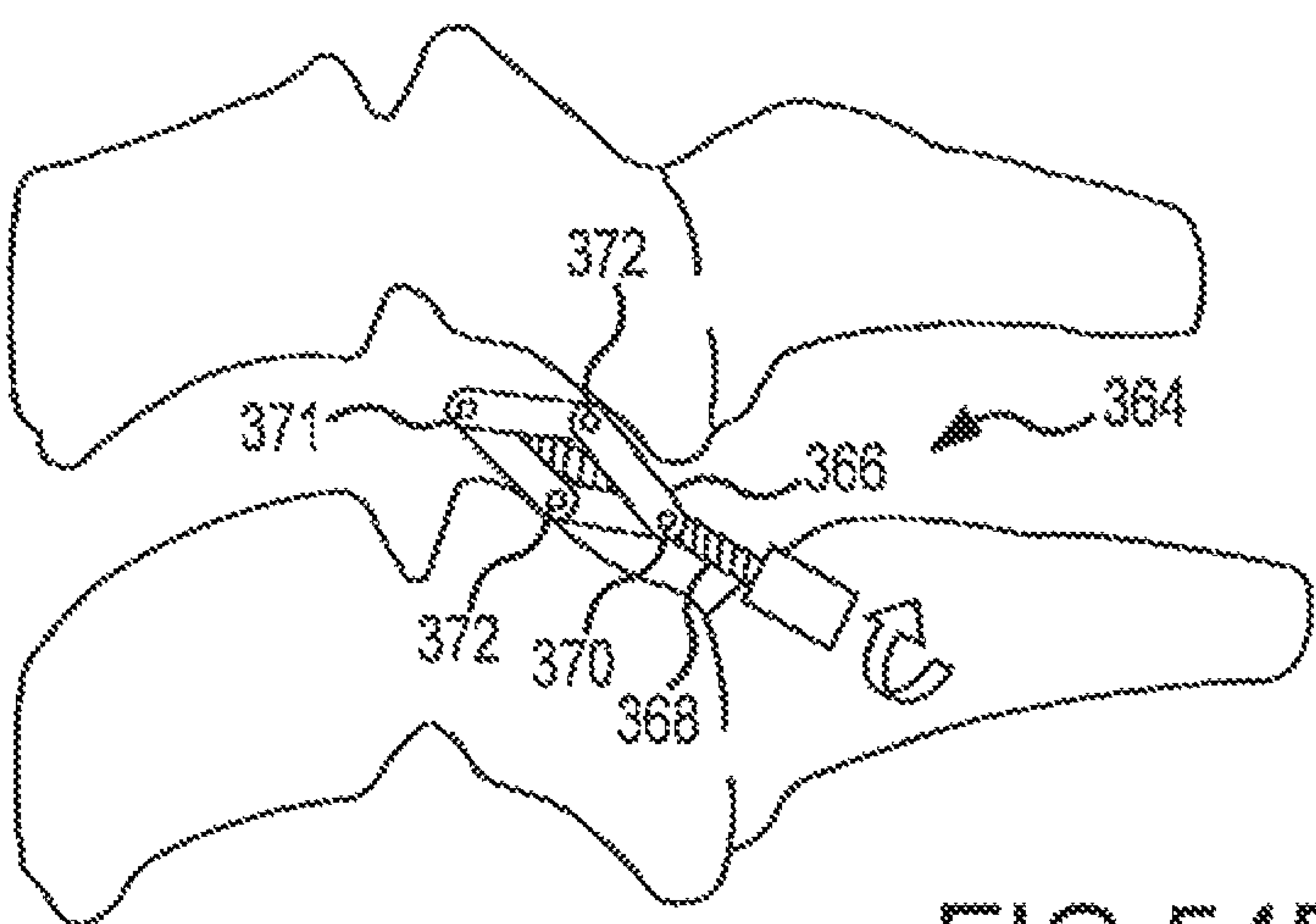


FIG.54B

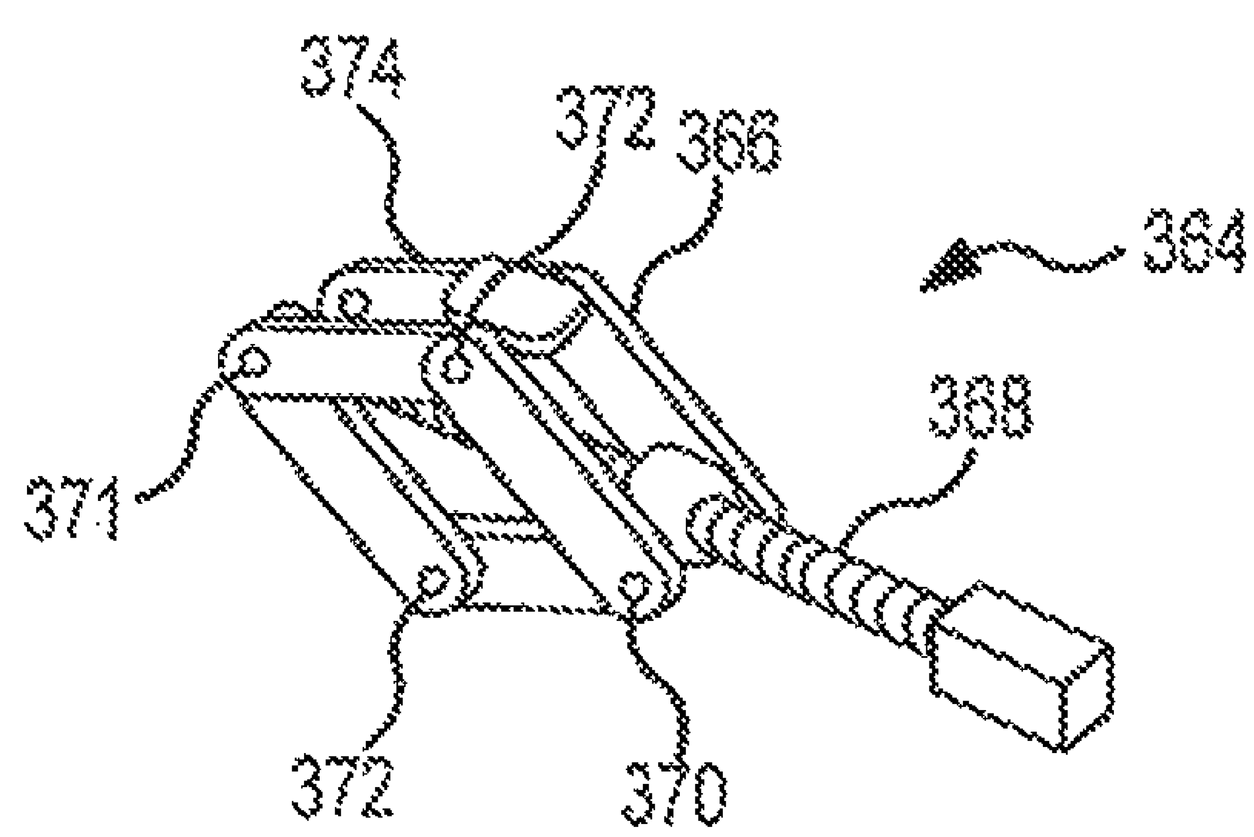


FIG.54C

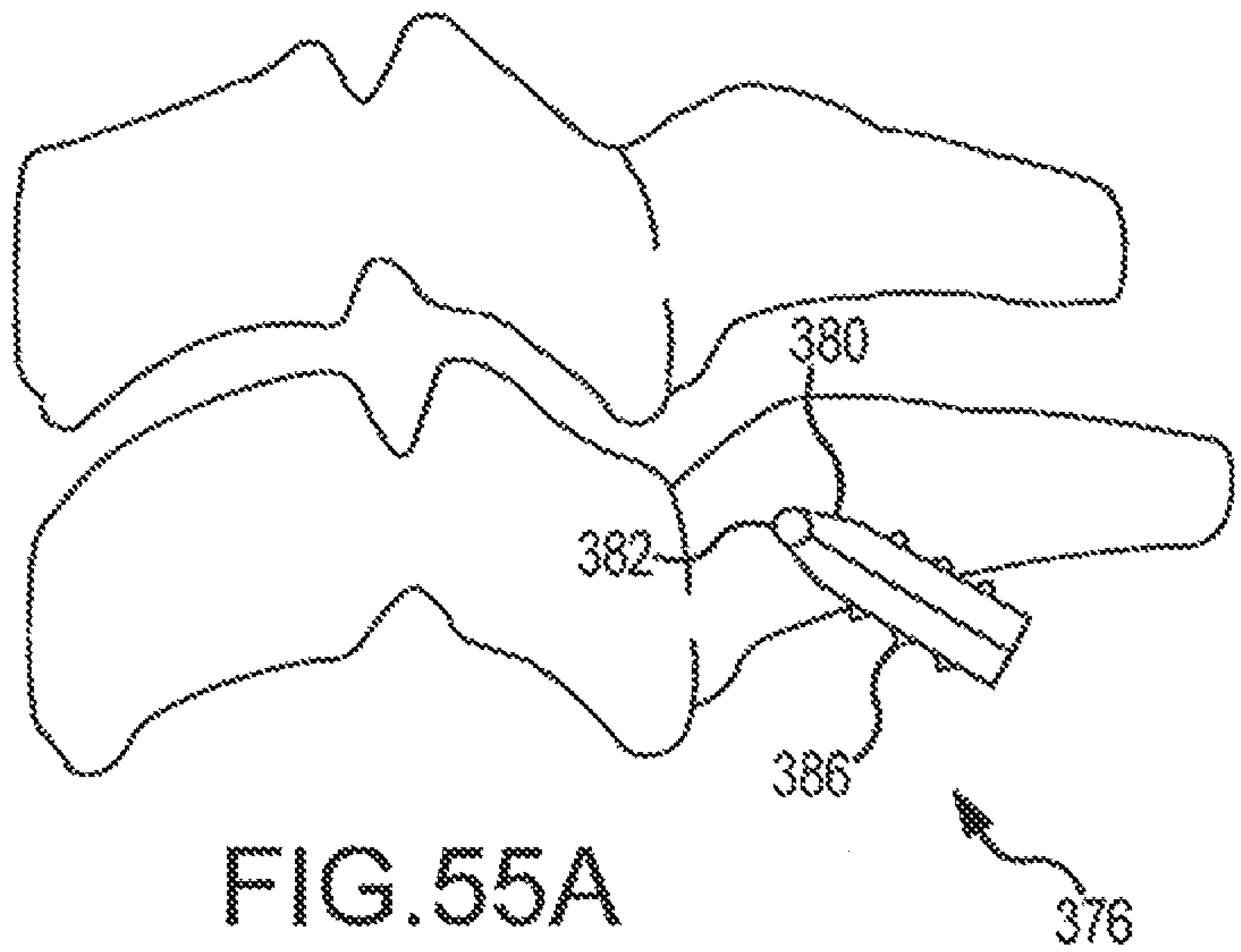


FIG.55A

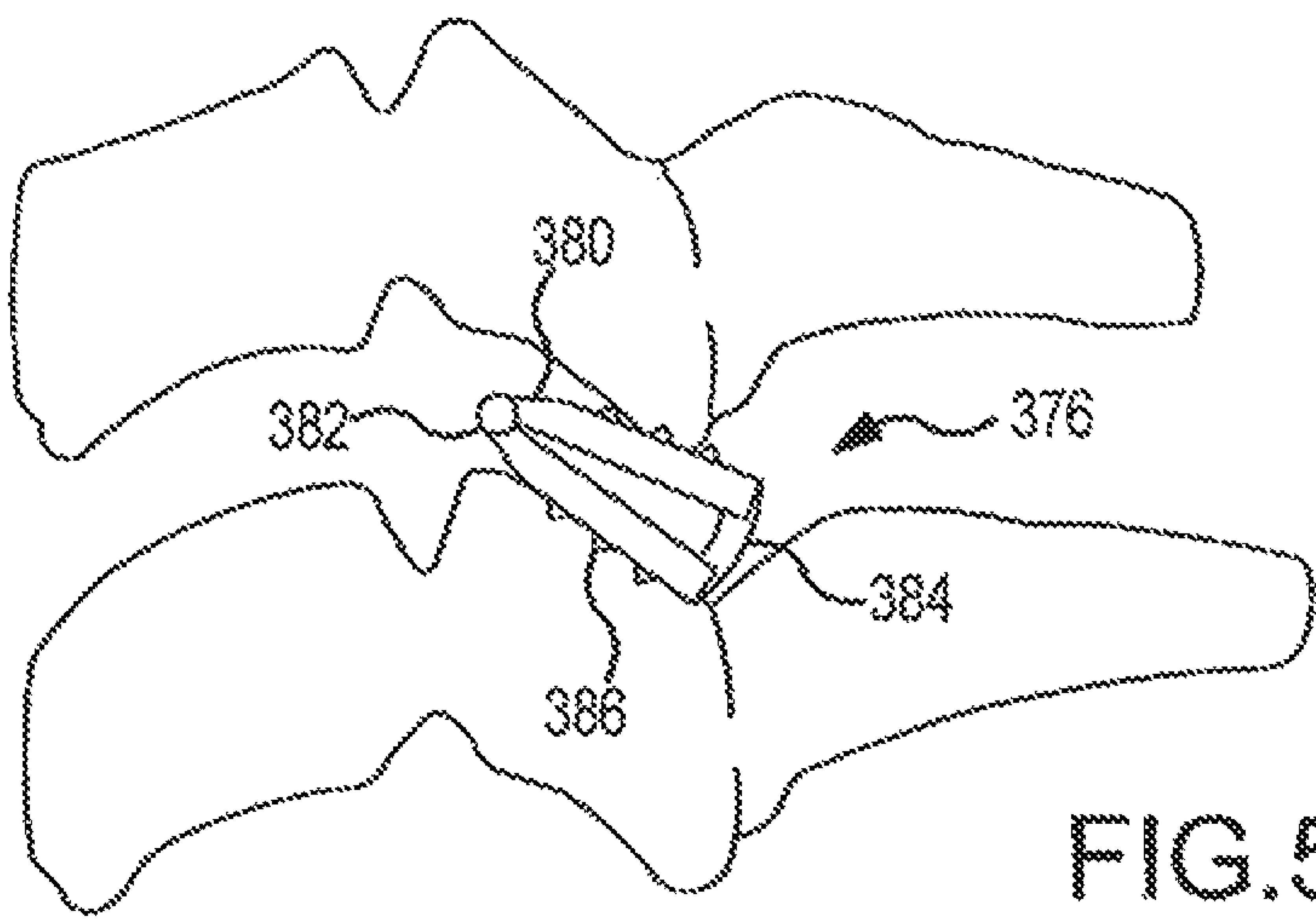


FIG.55B

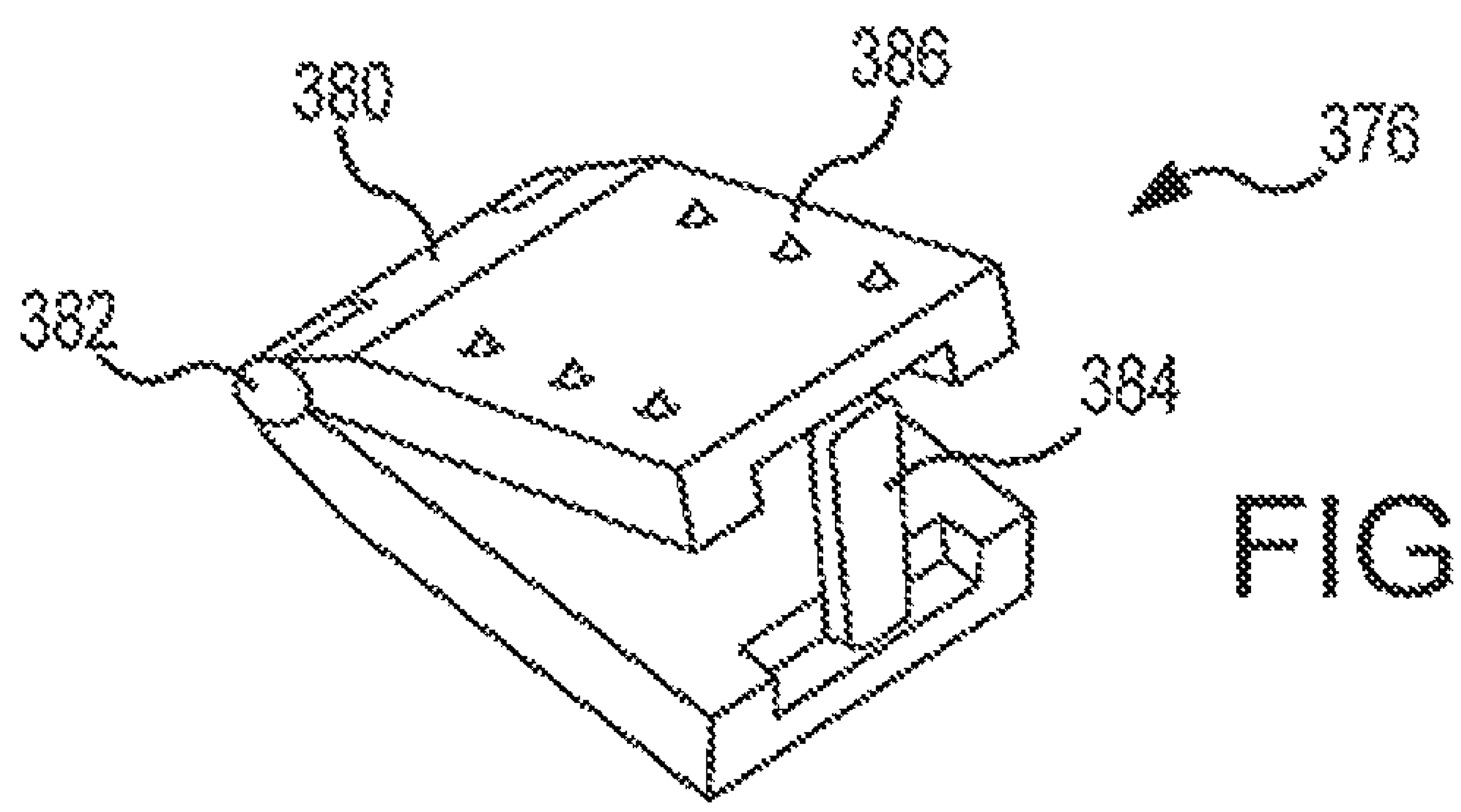


FIG.55C

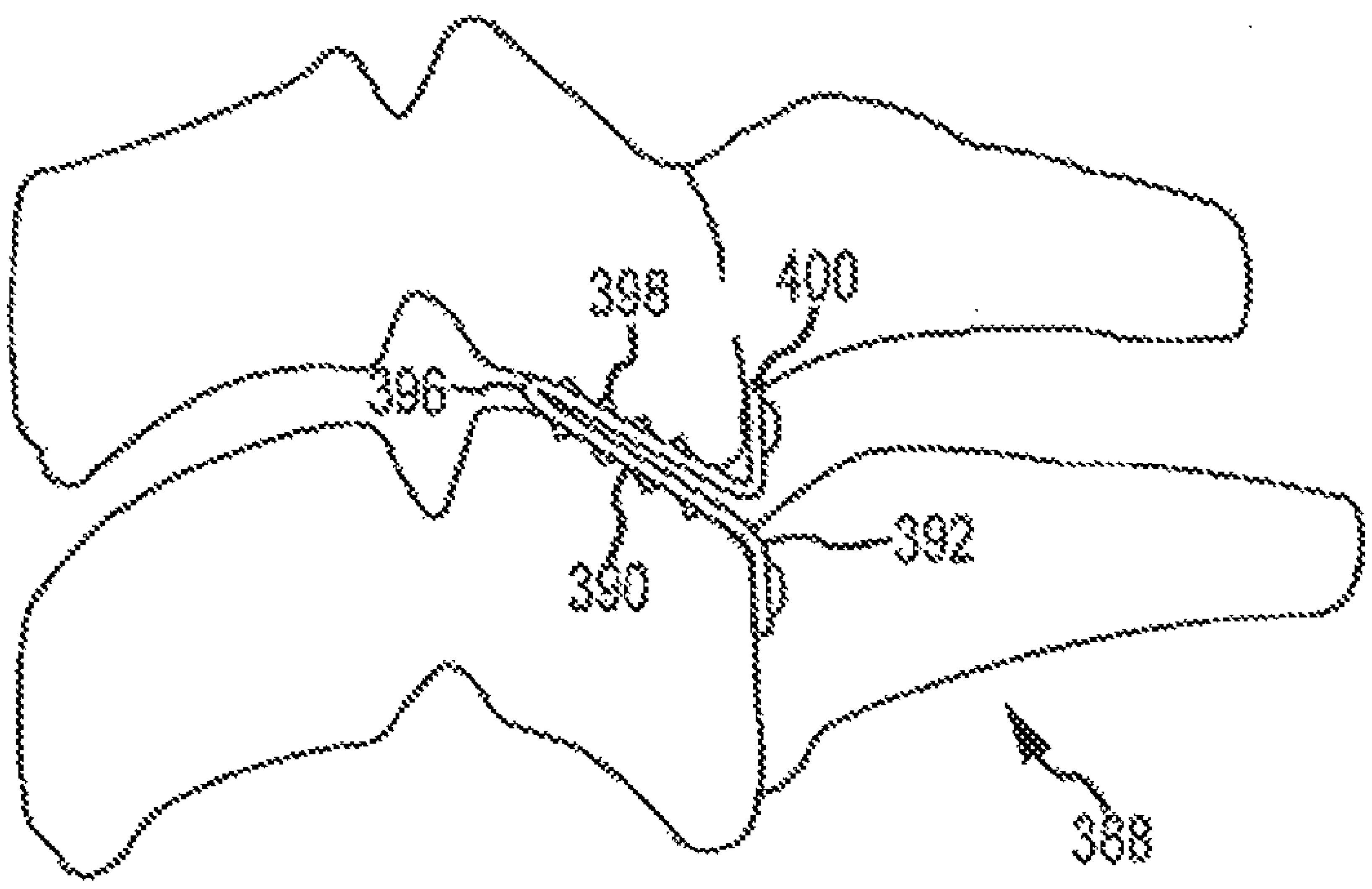


FIG.56A

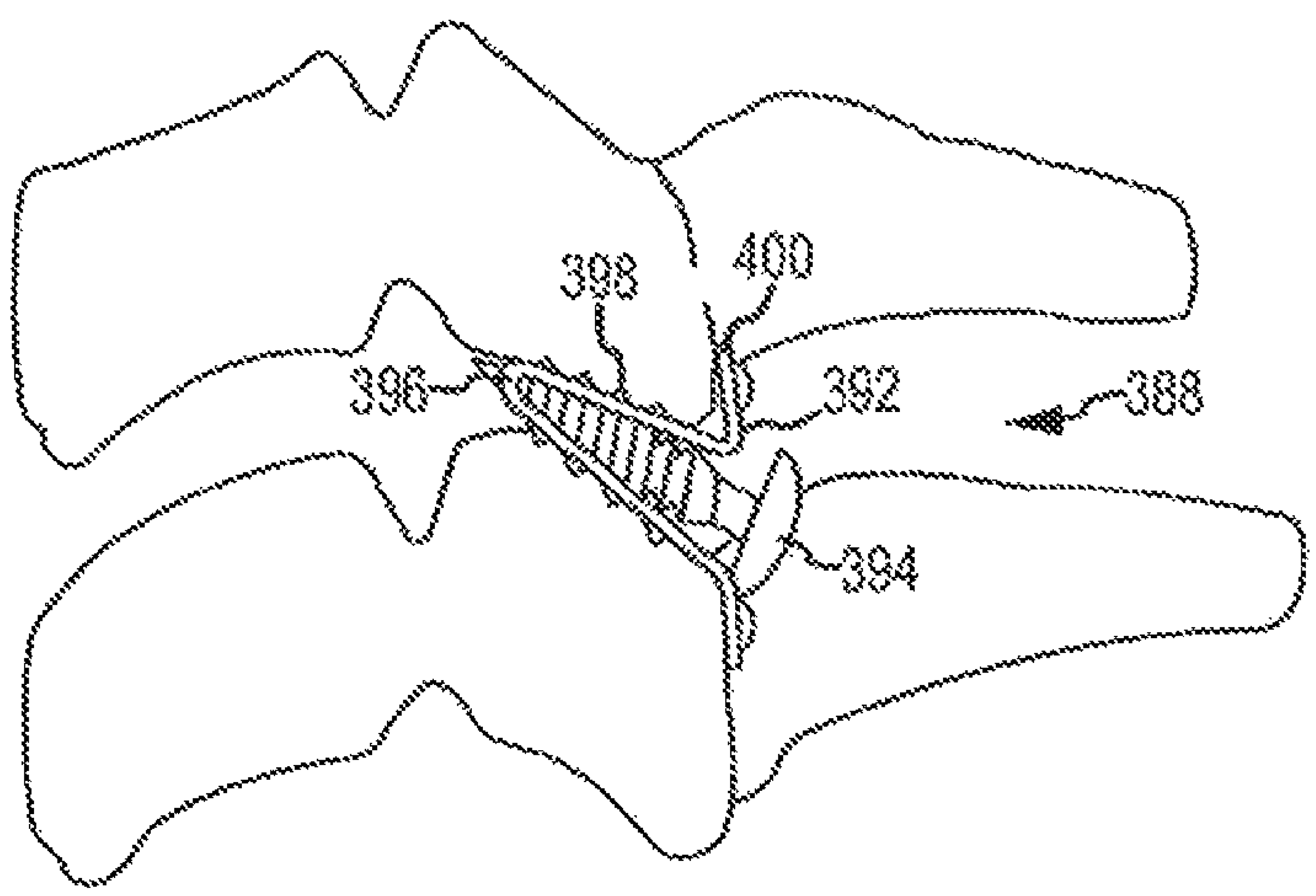


FIG.56B

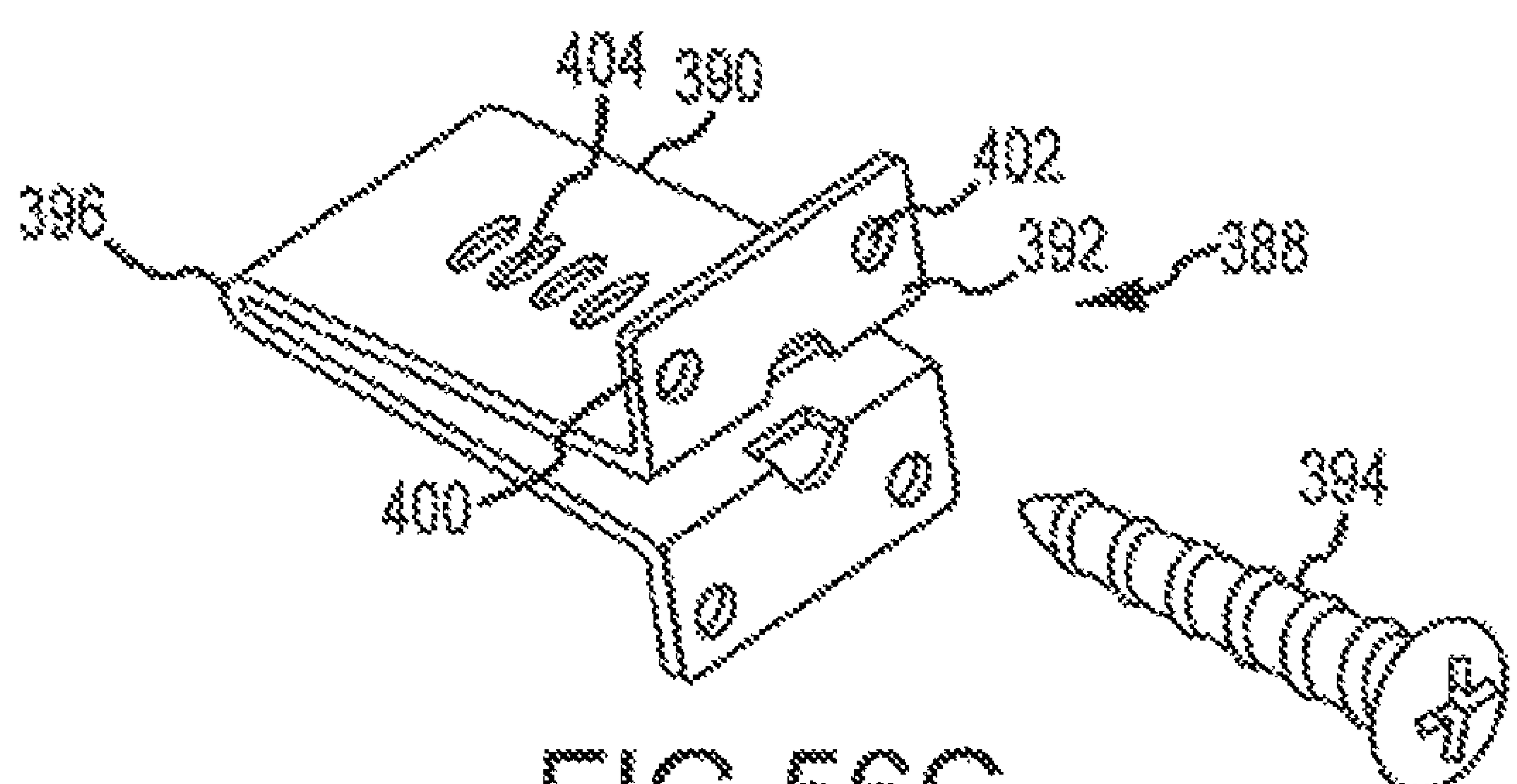


FIG.56C

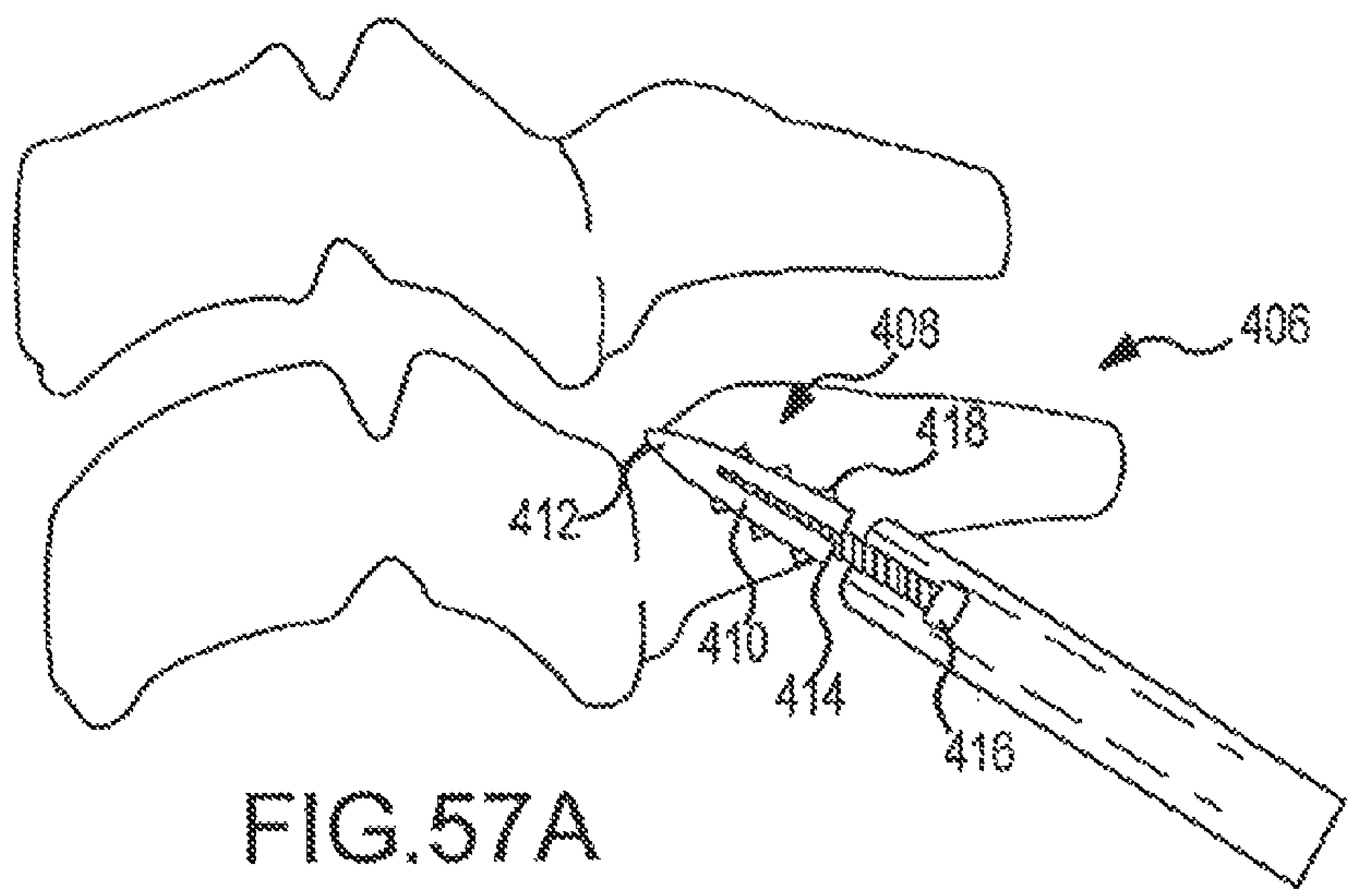


FIG.57A

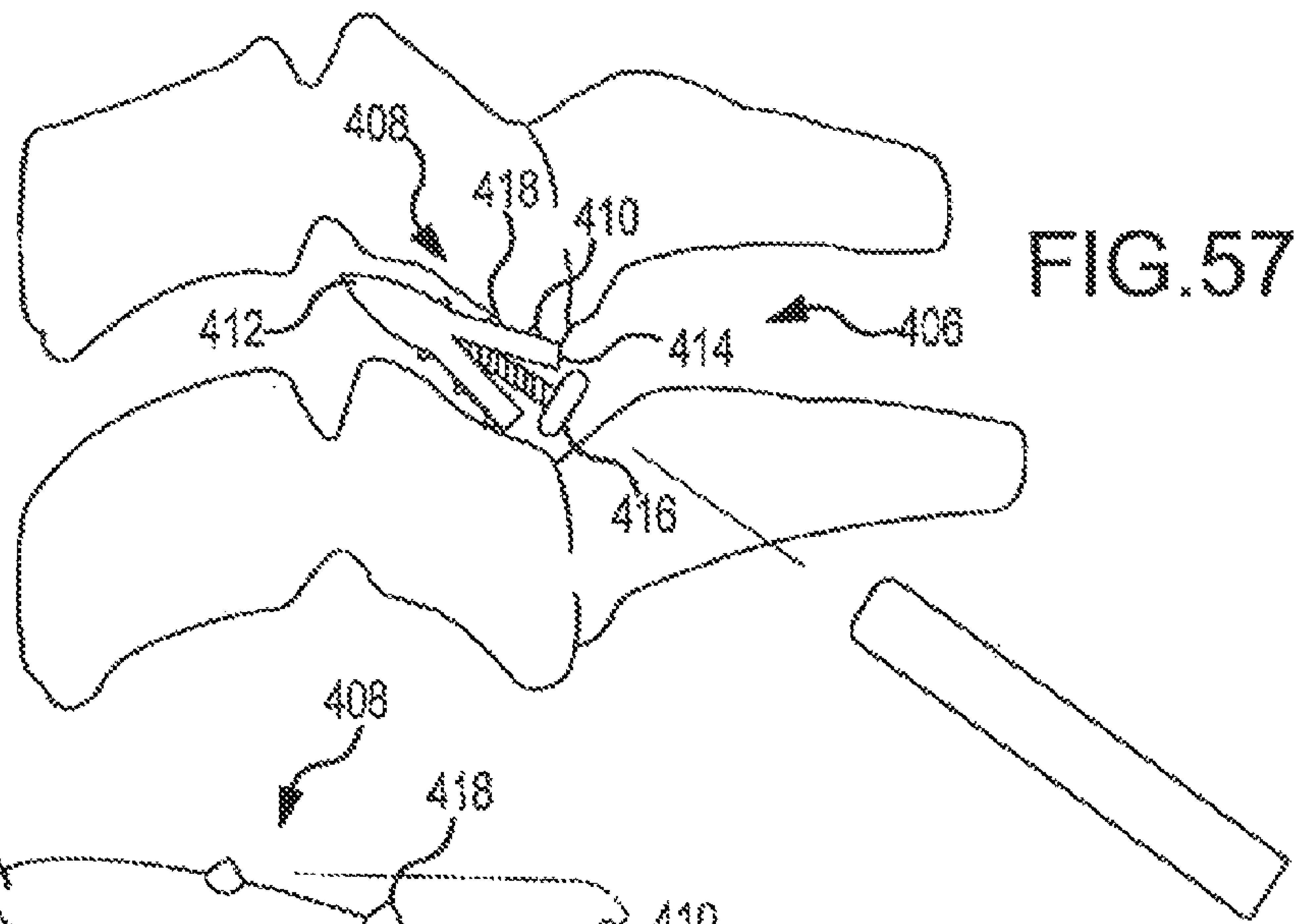


FIG.57B

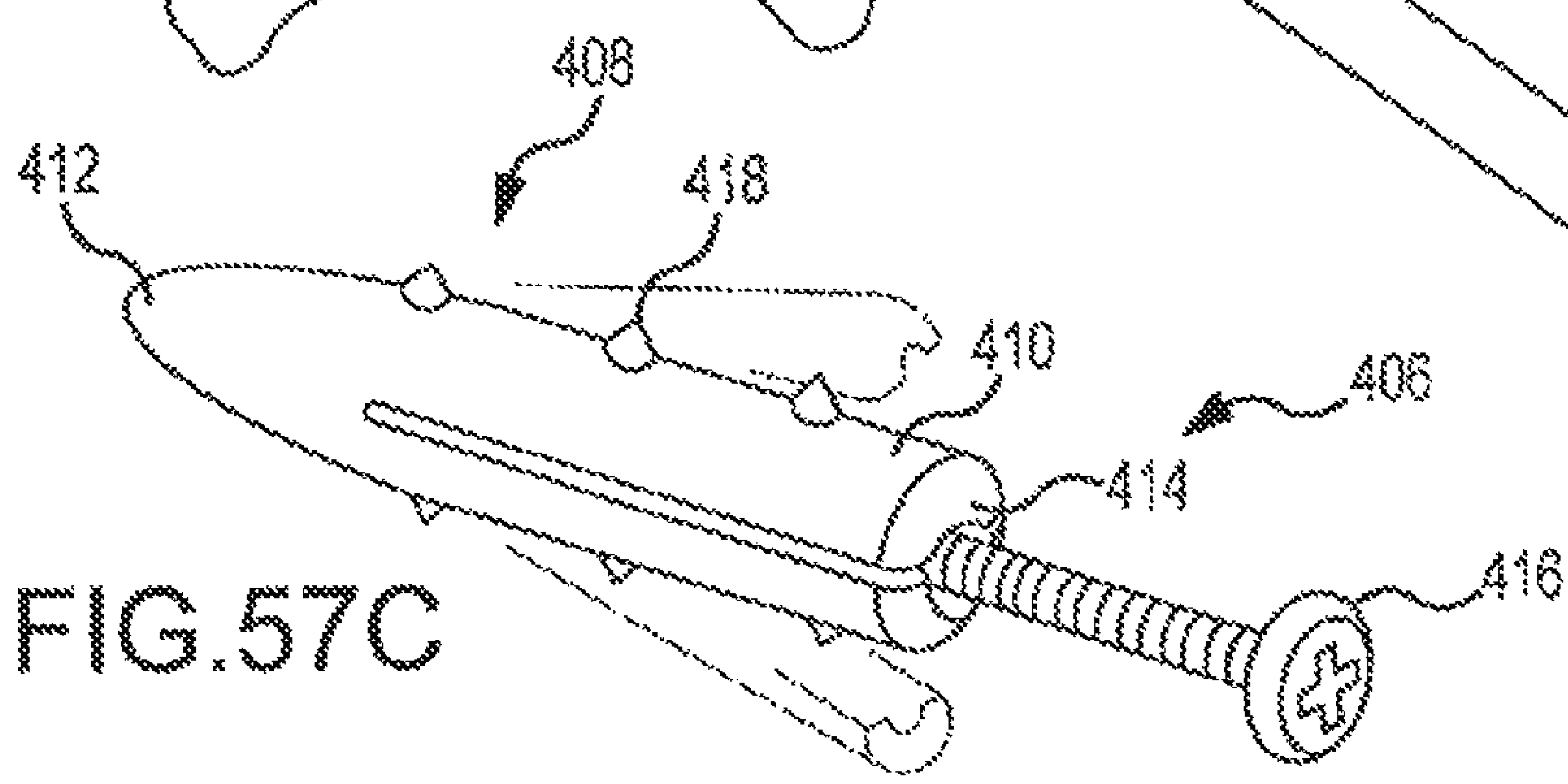


FIG.57C

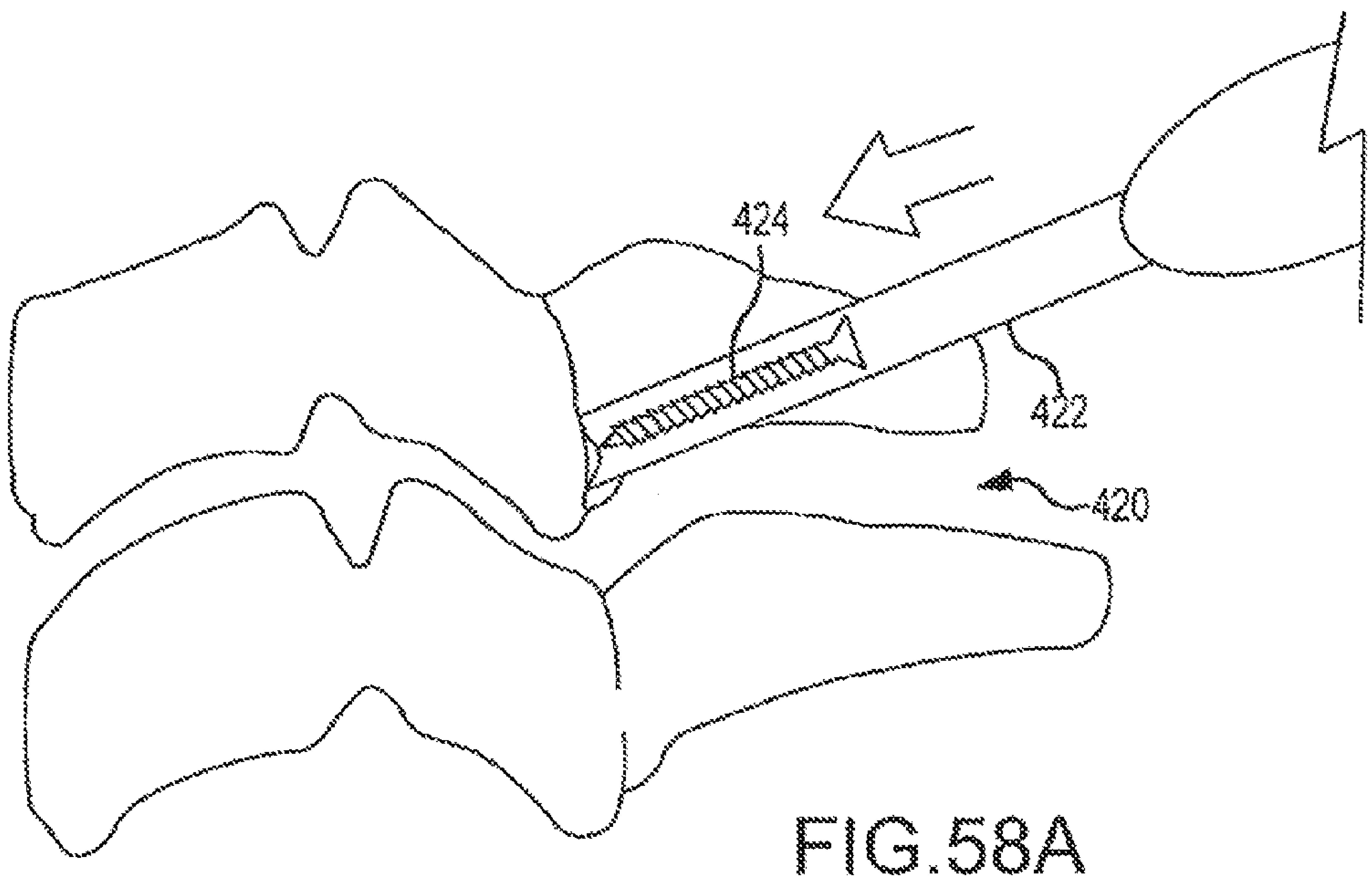


FIG.58A

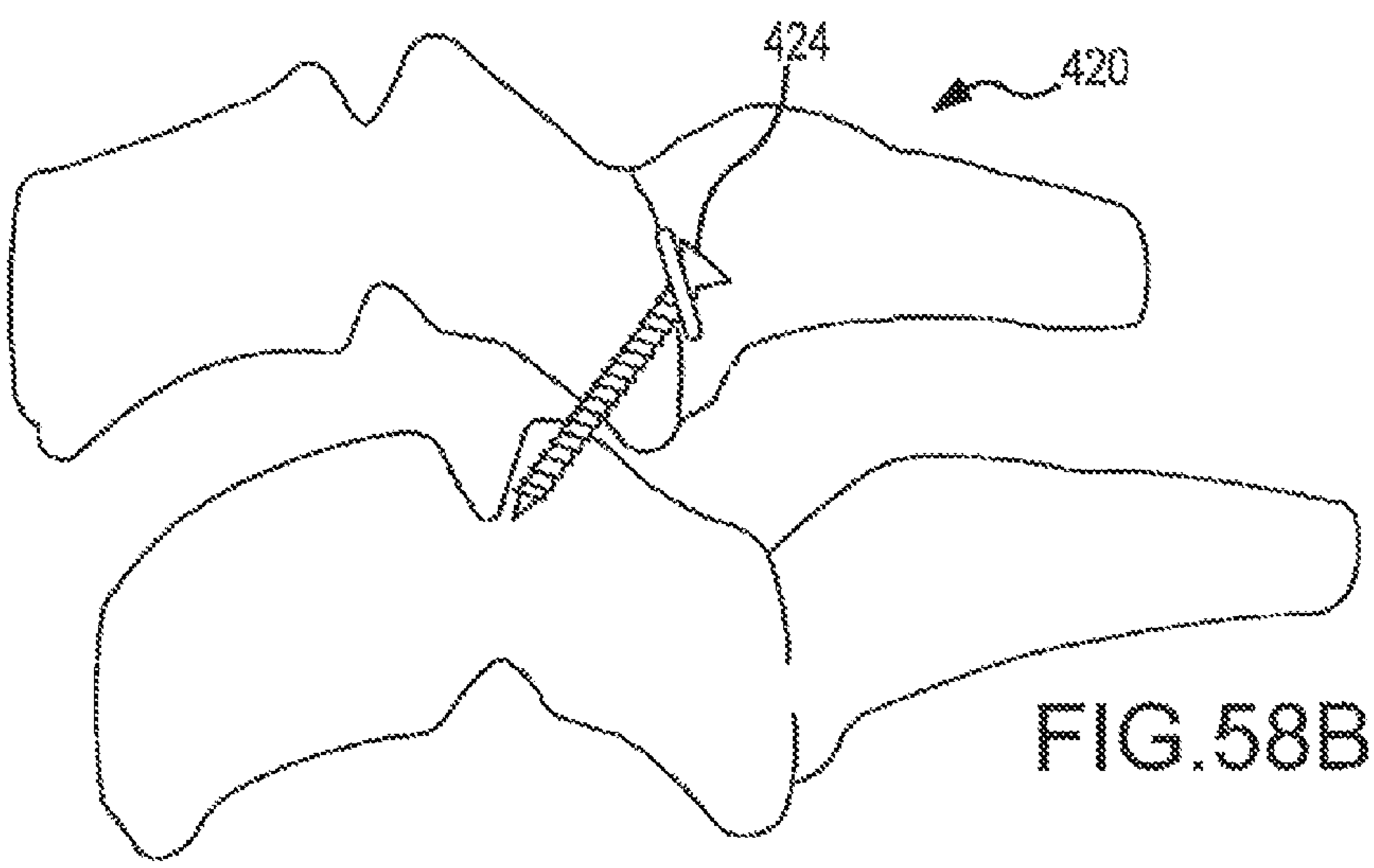


FIG.58B

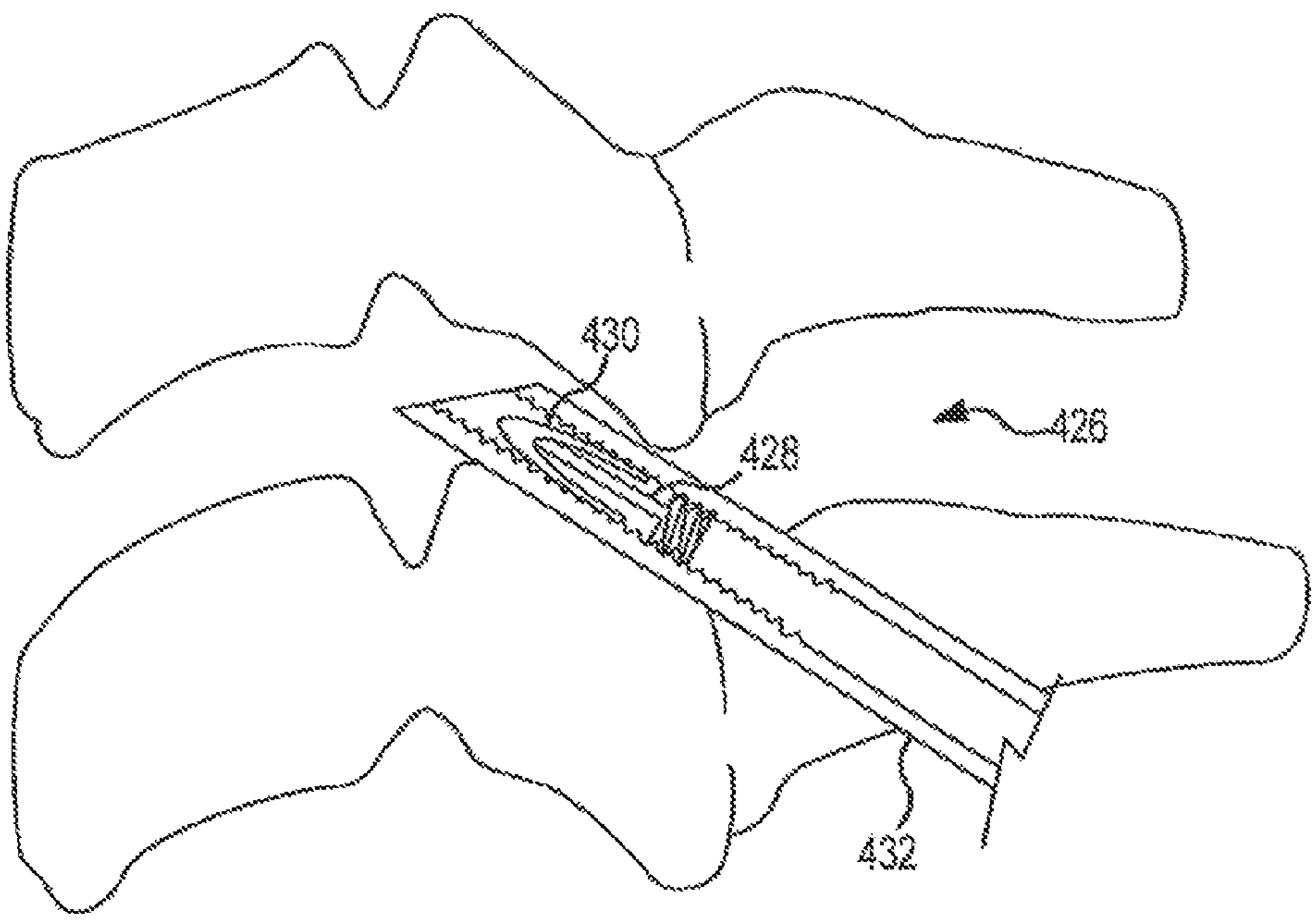


FIG.59A

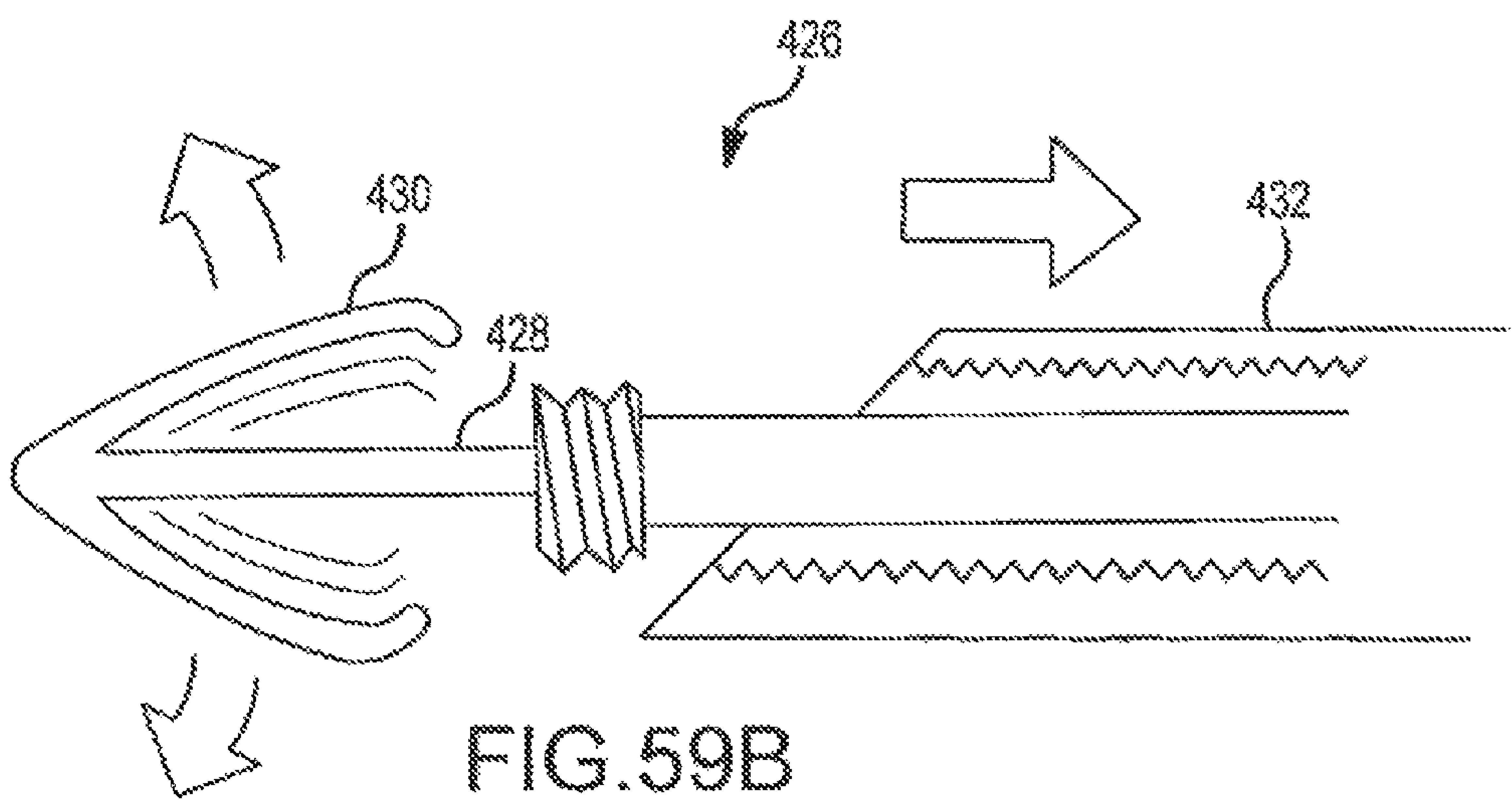


FIG.59B

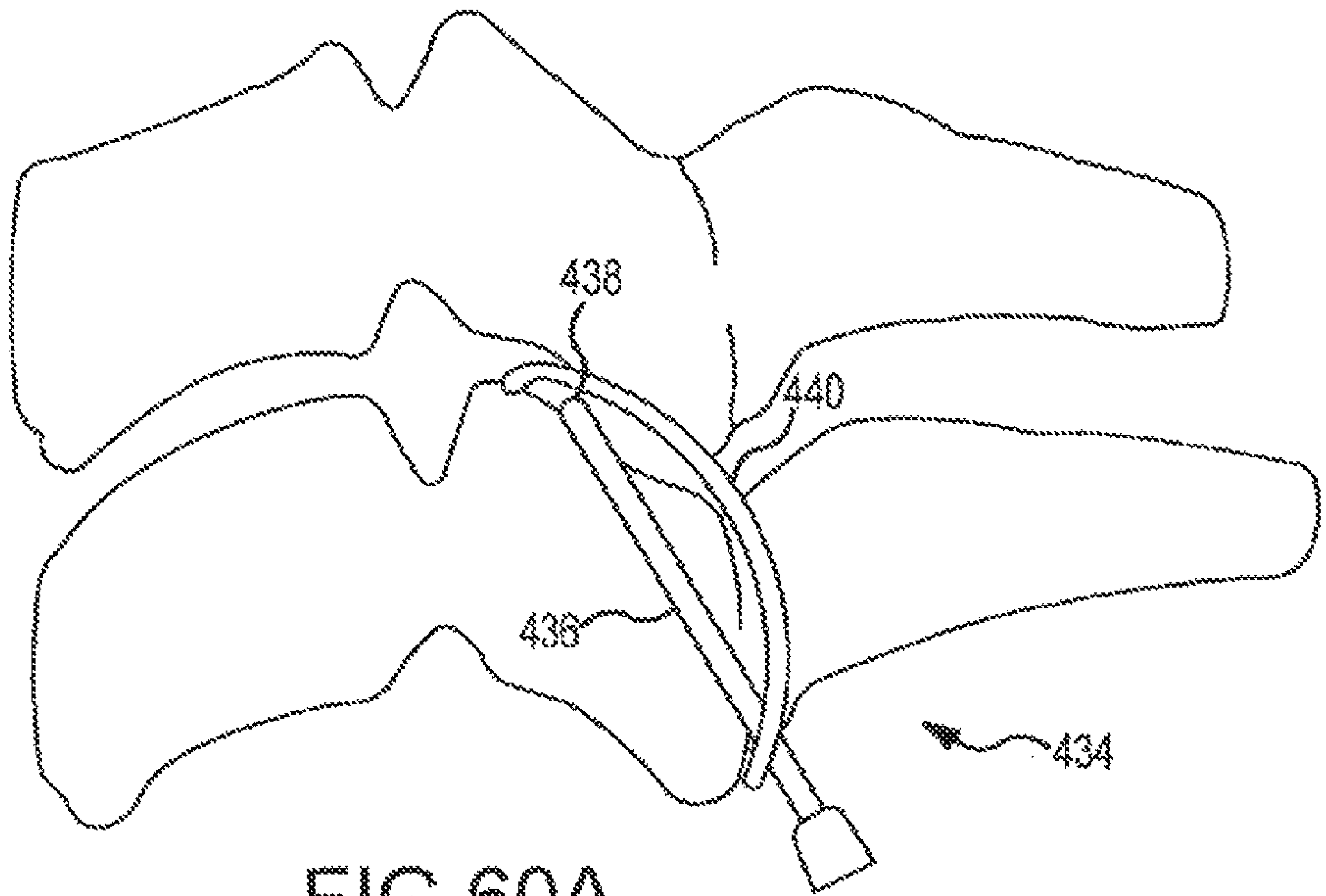


FIG.60A

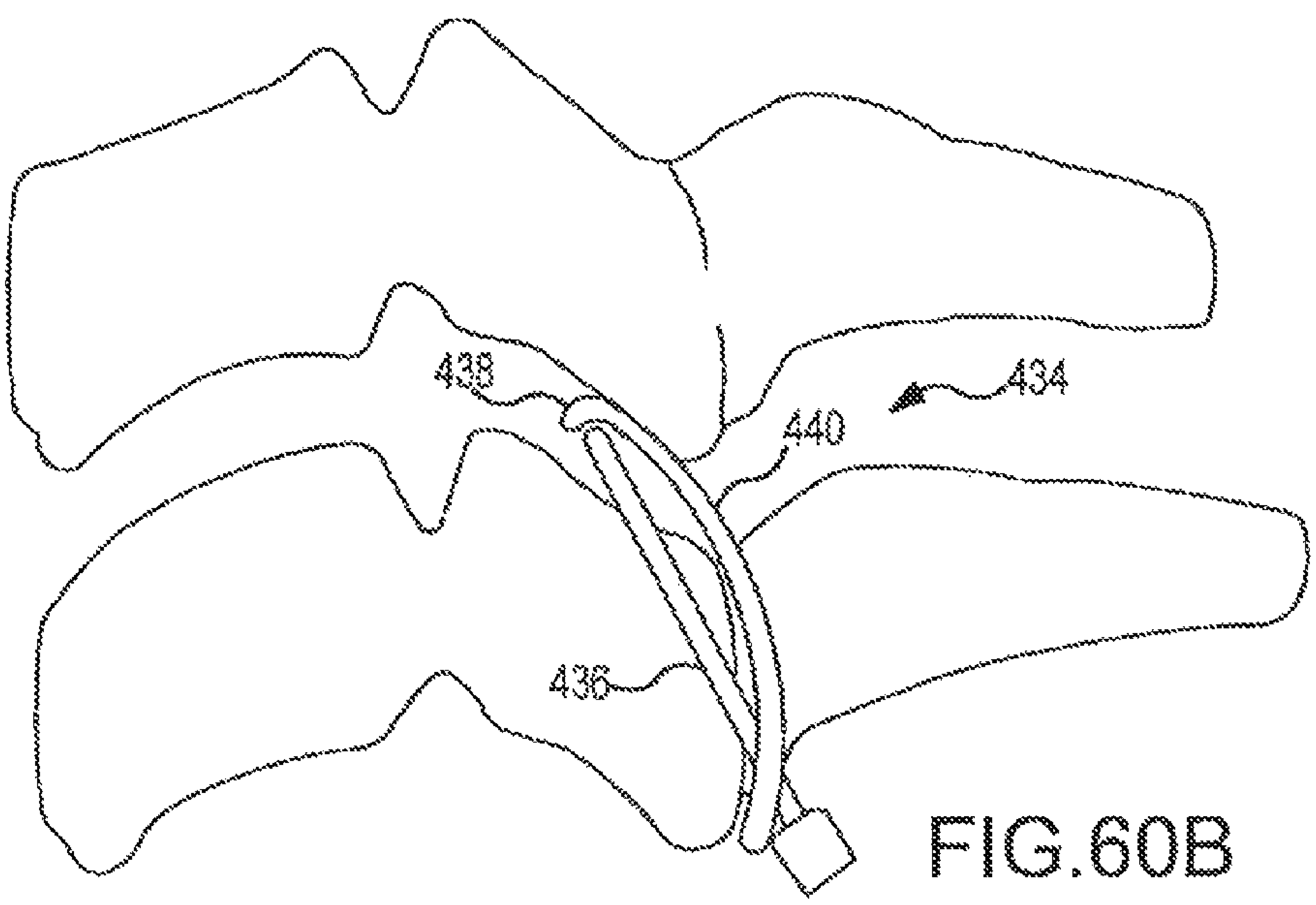


FIG.60B

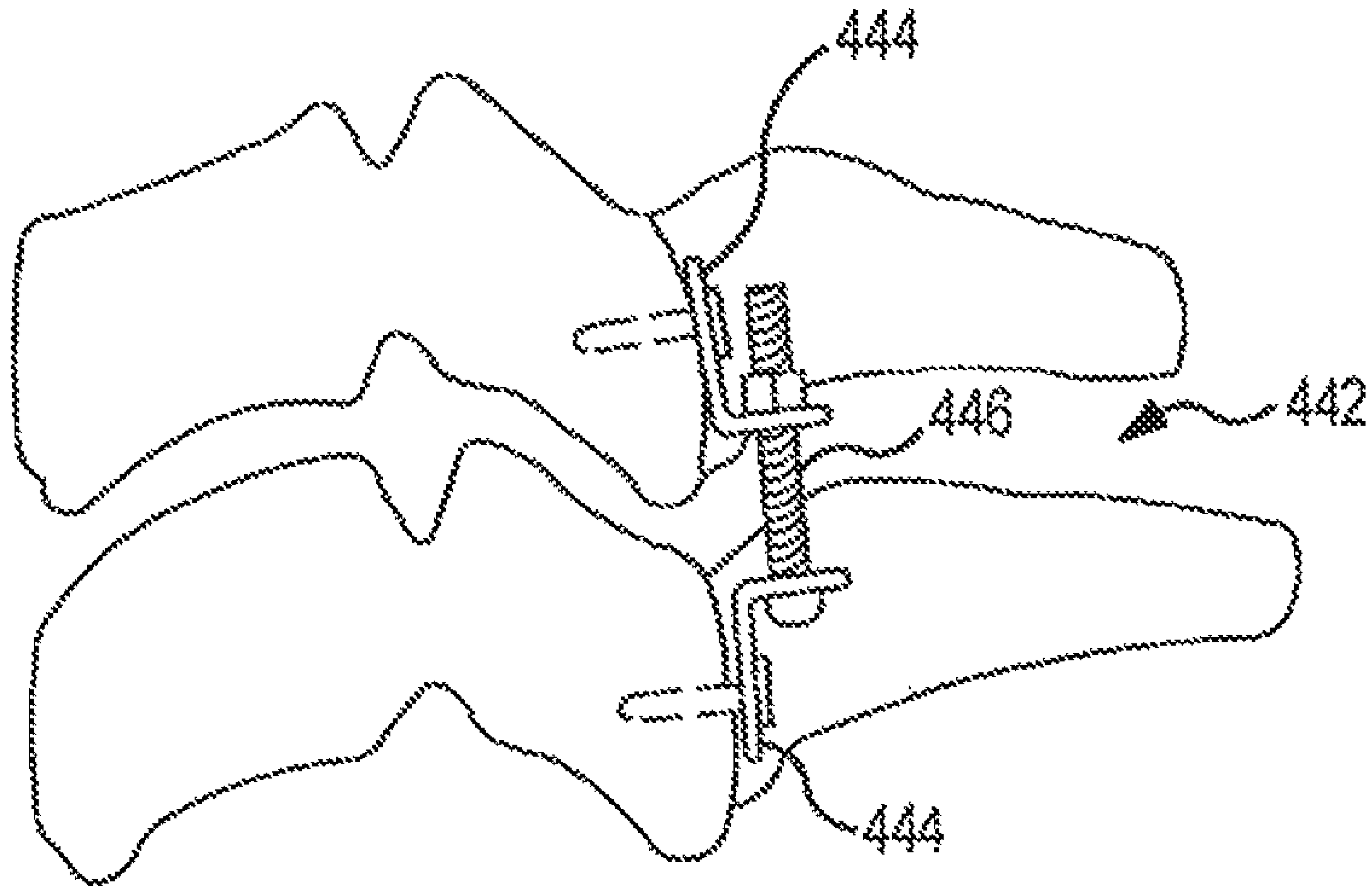


FIG.61A

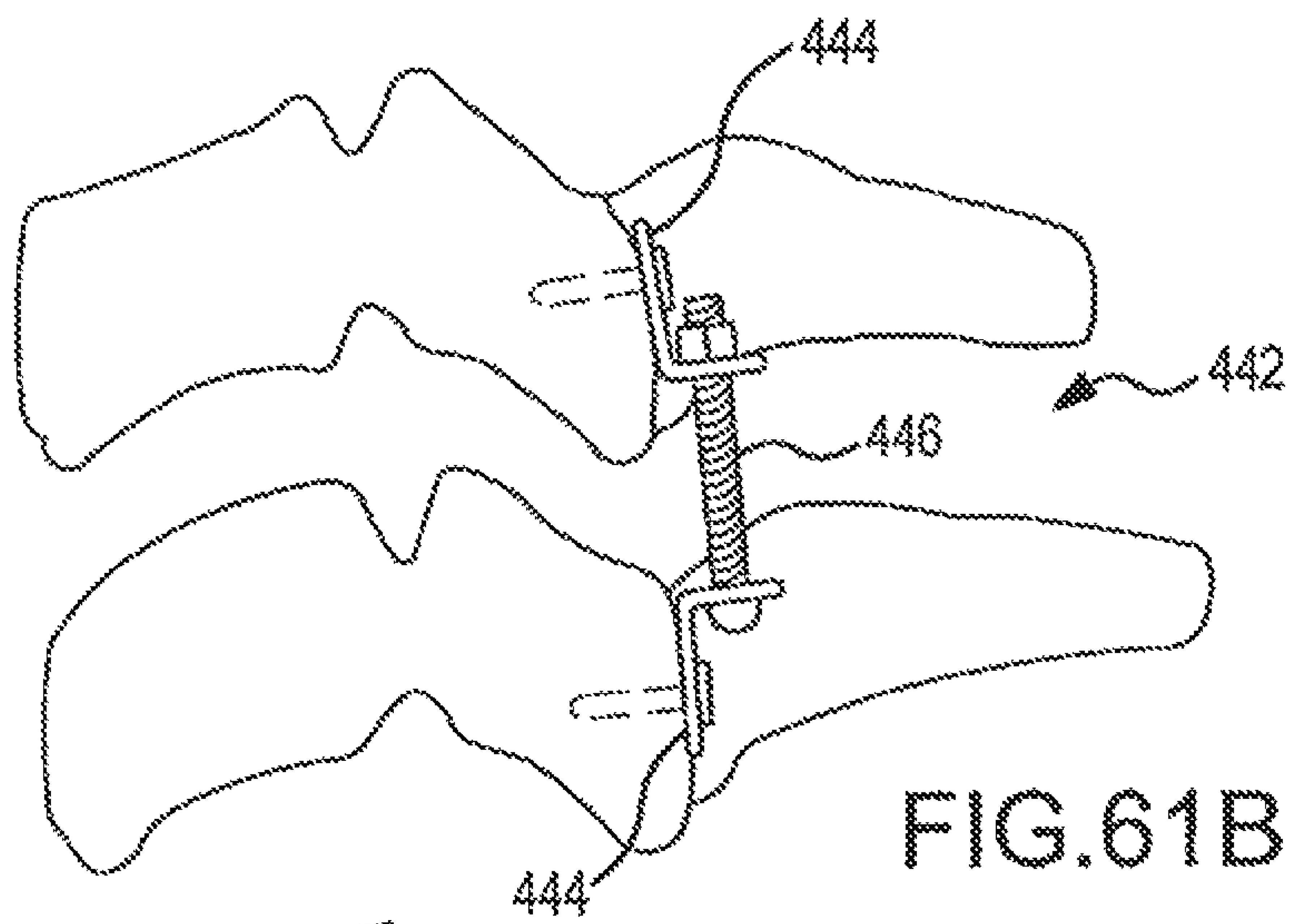


FIG.61B

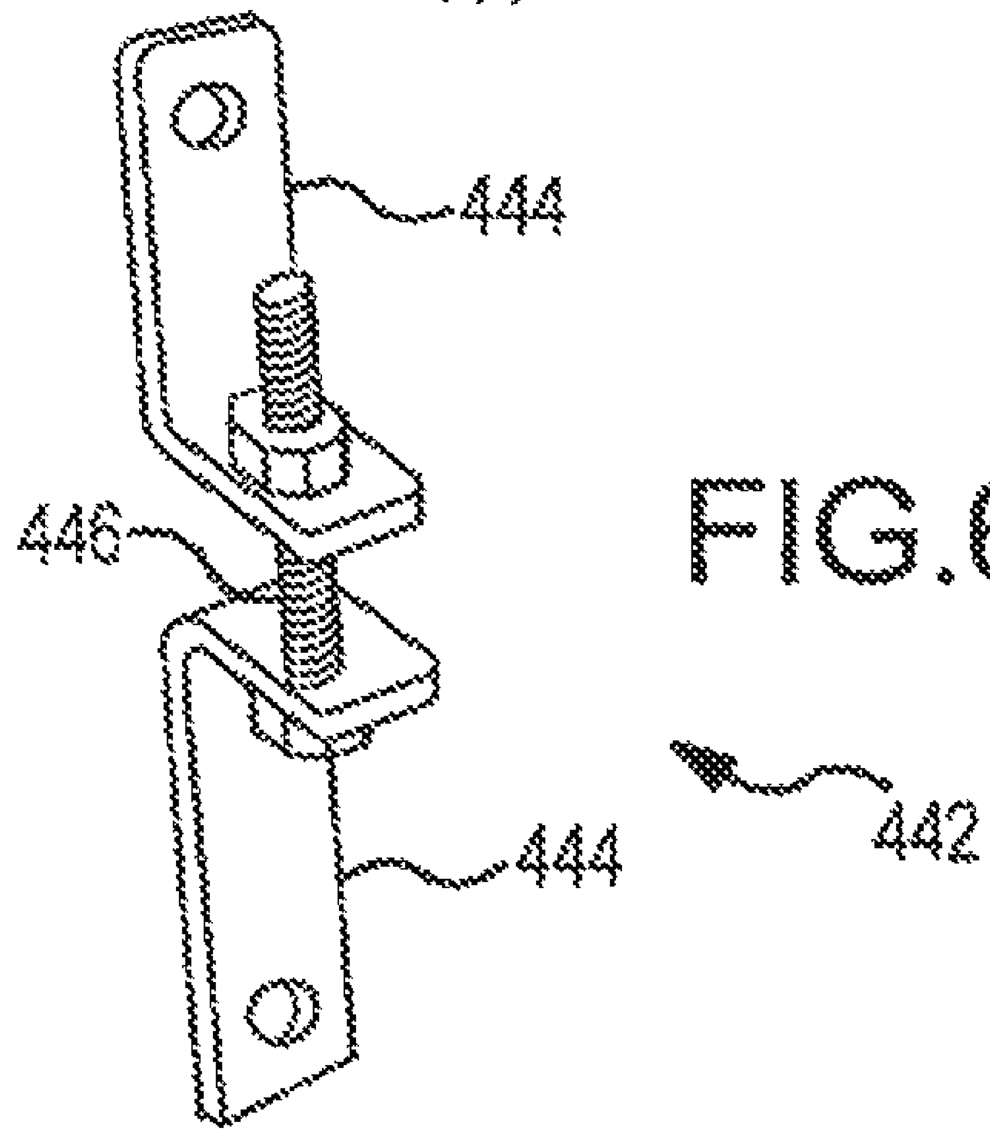


FIG.61C

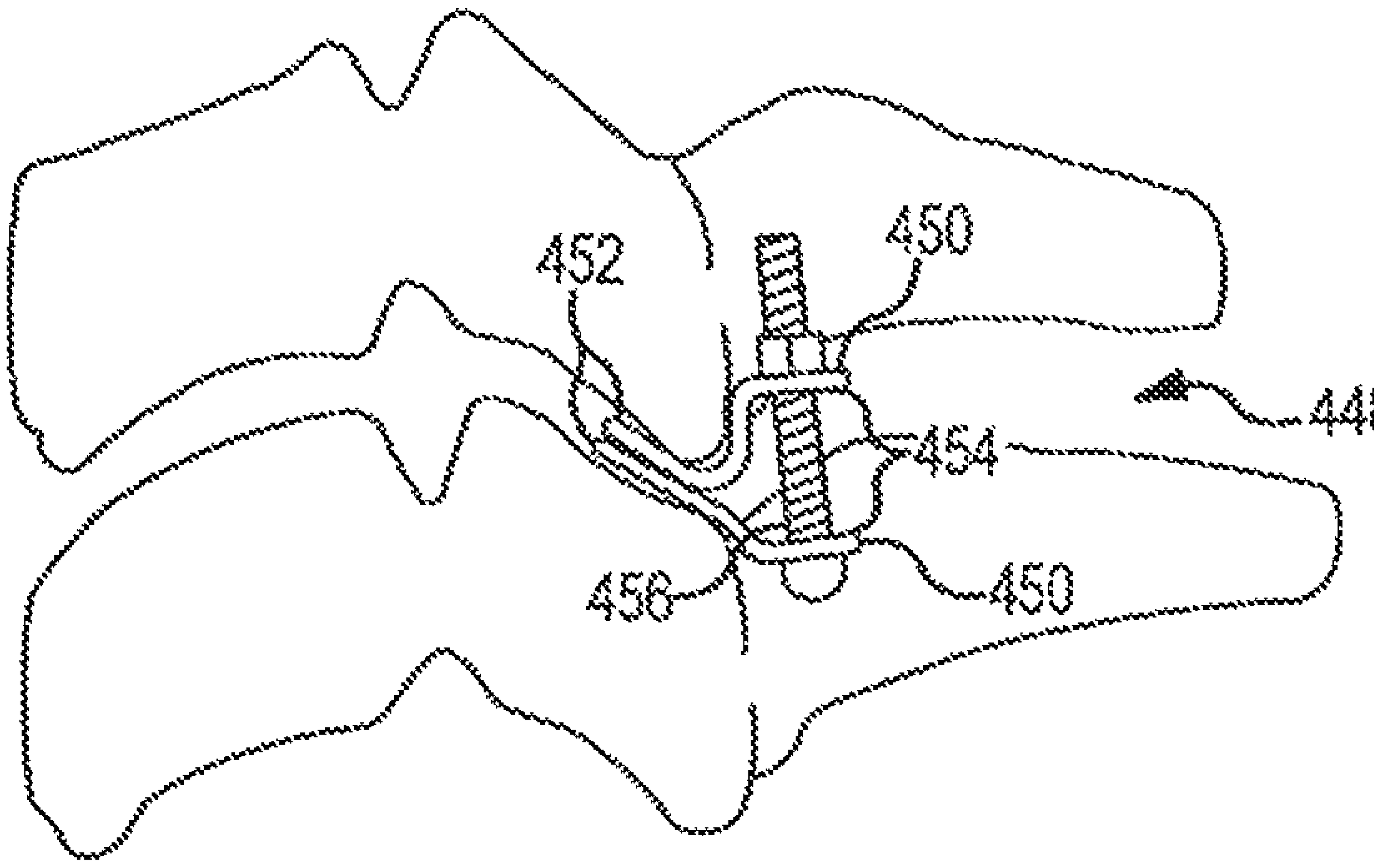


FIG.62A

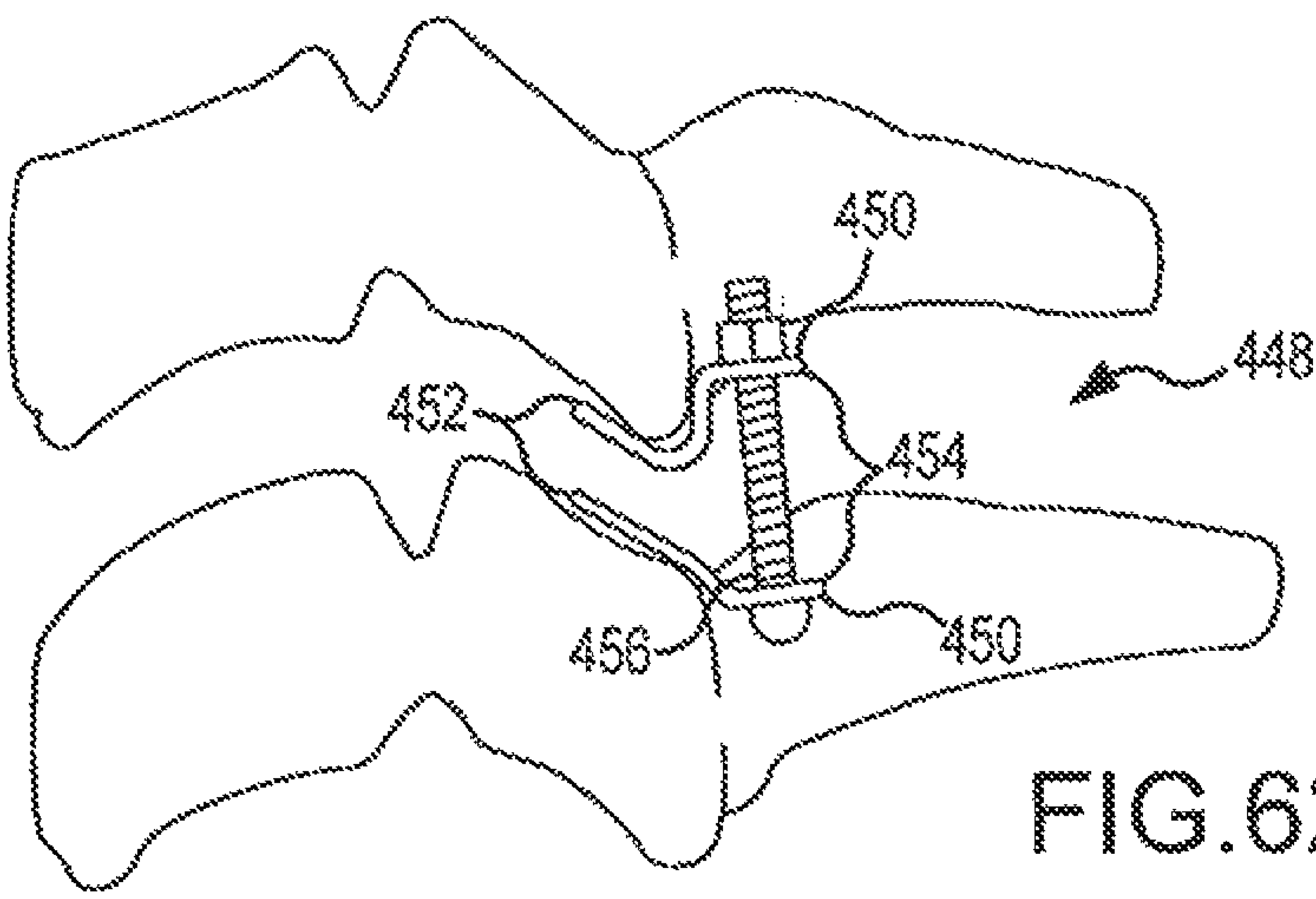


FIG.62B

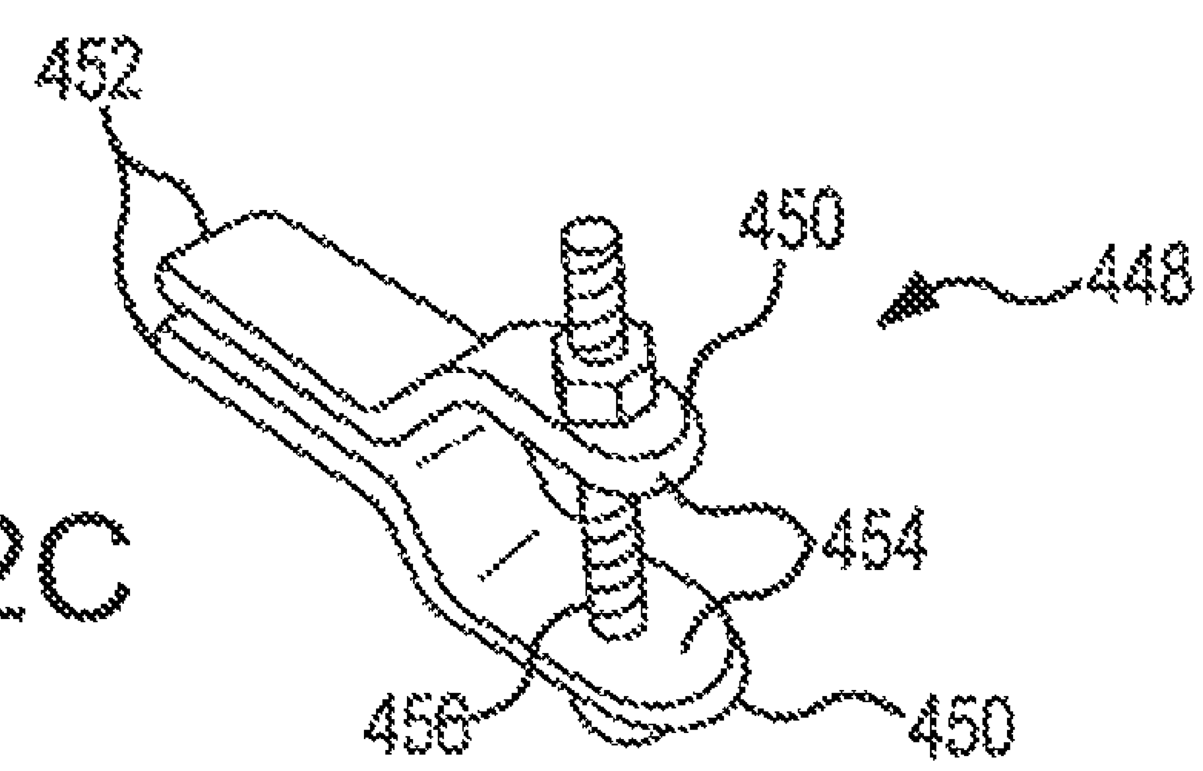


FIG.62C

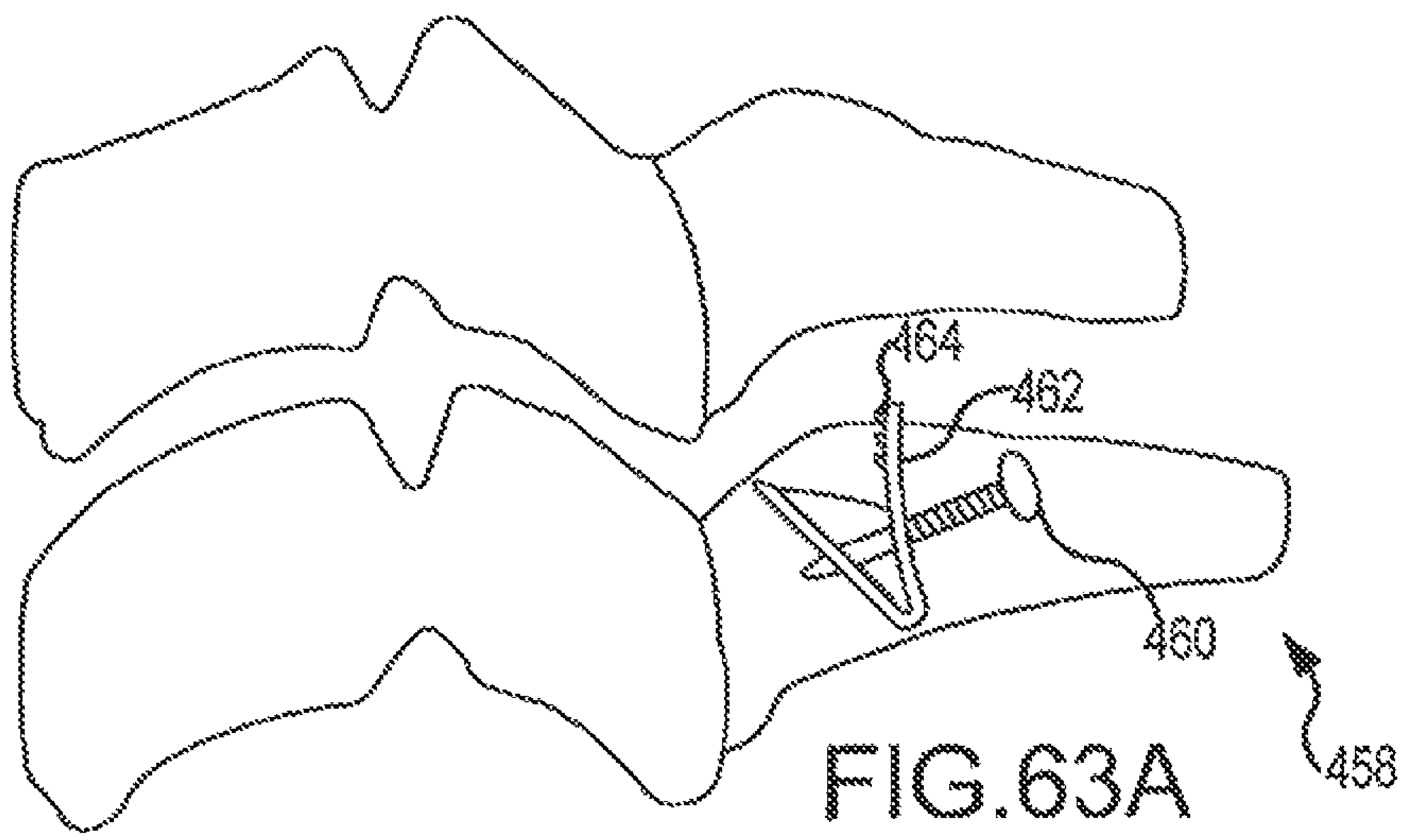


FIG.63A

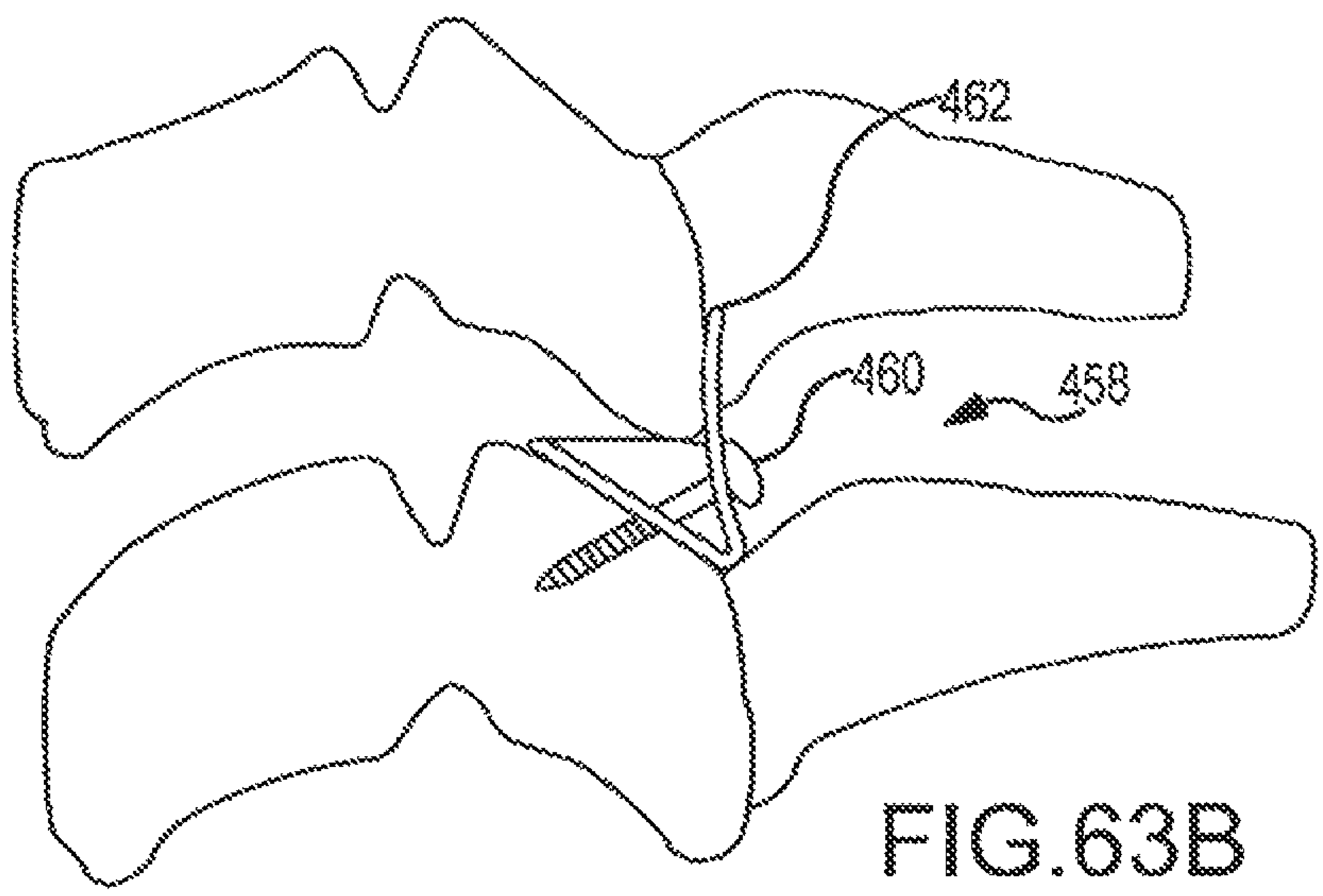


FIG.63B

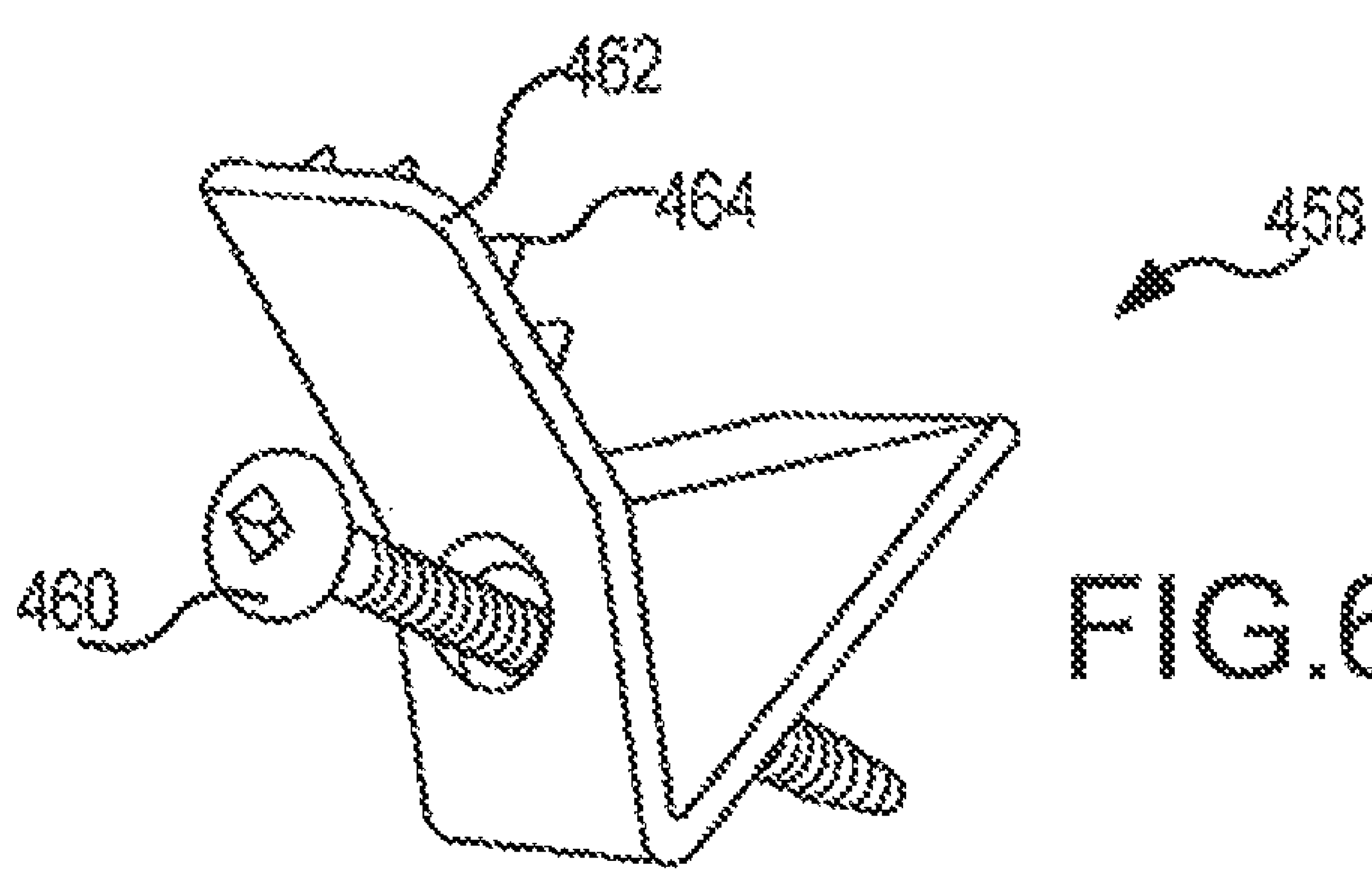


FIG.63C

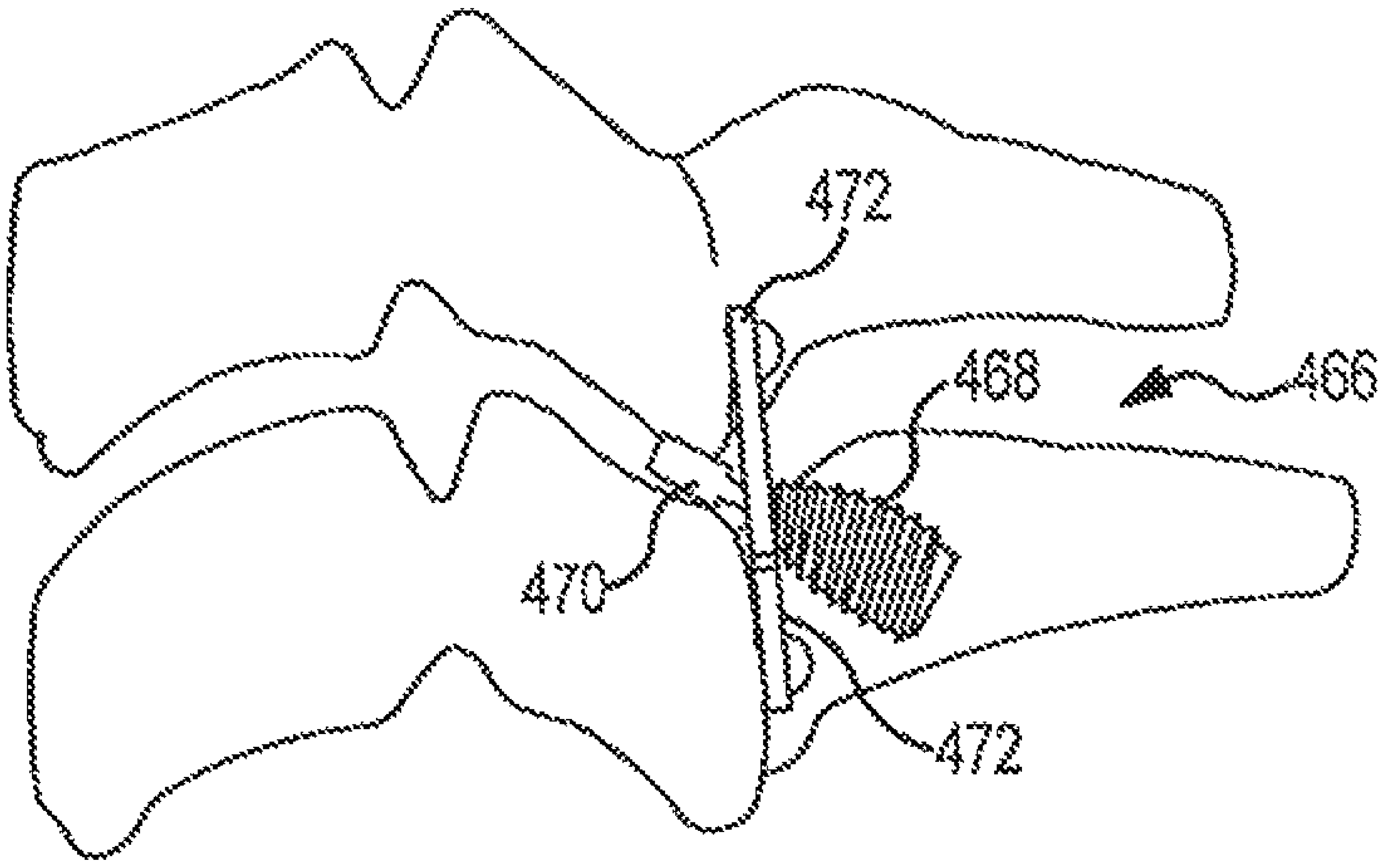


FIG.64A

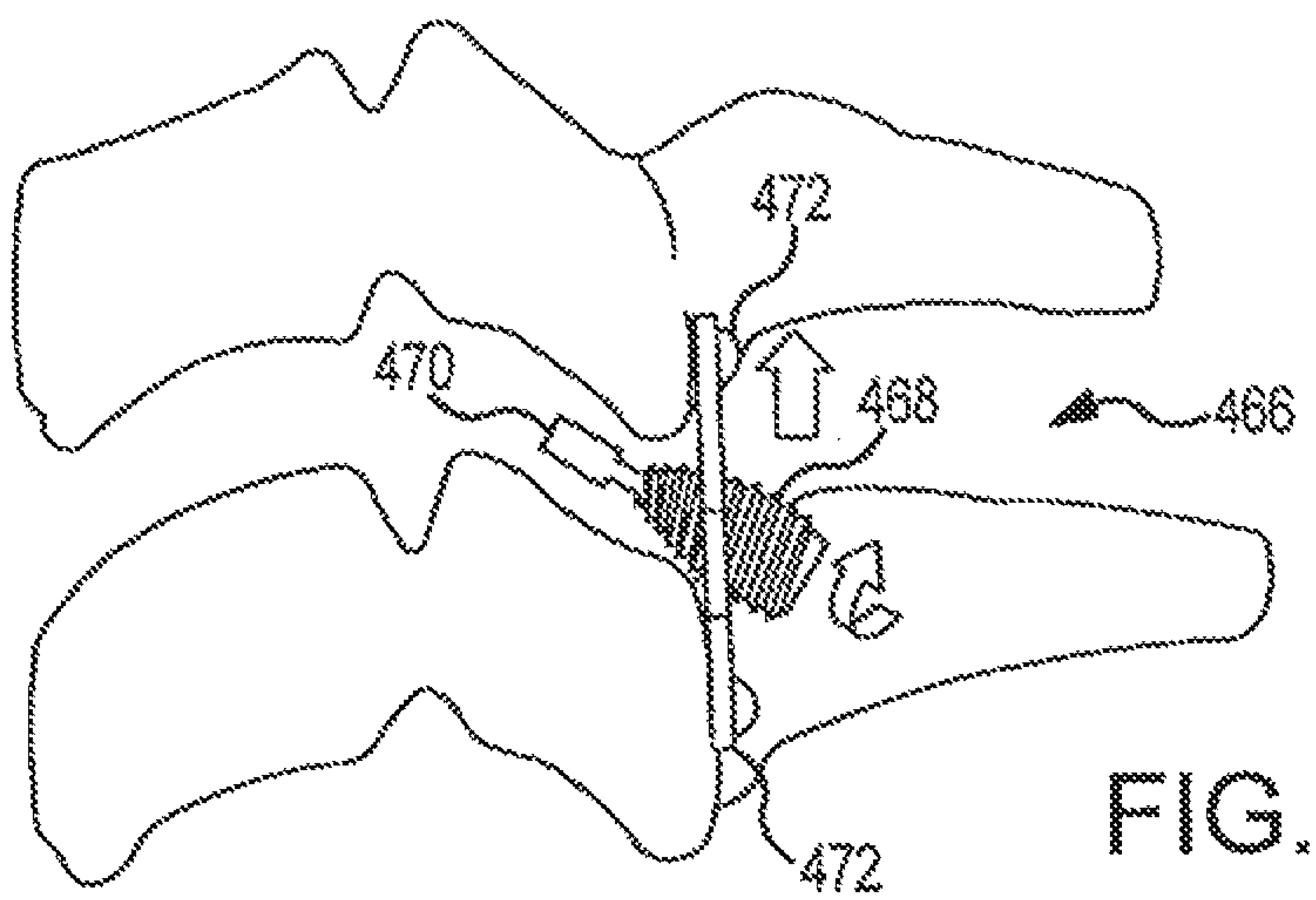


FIG.64B

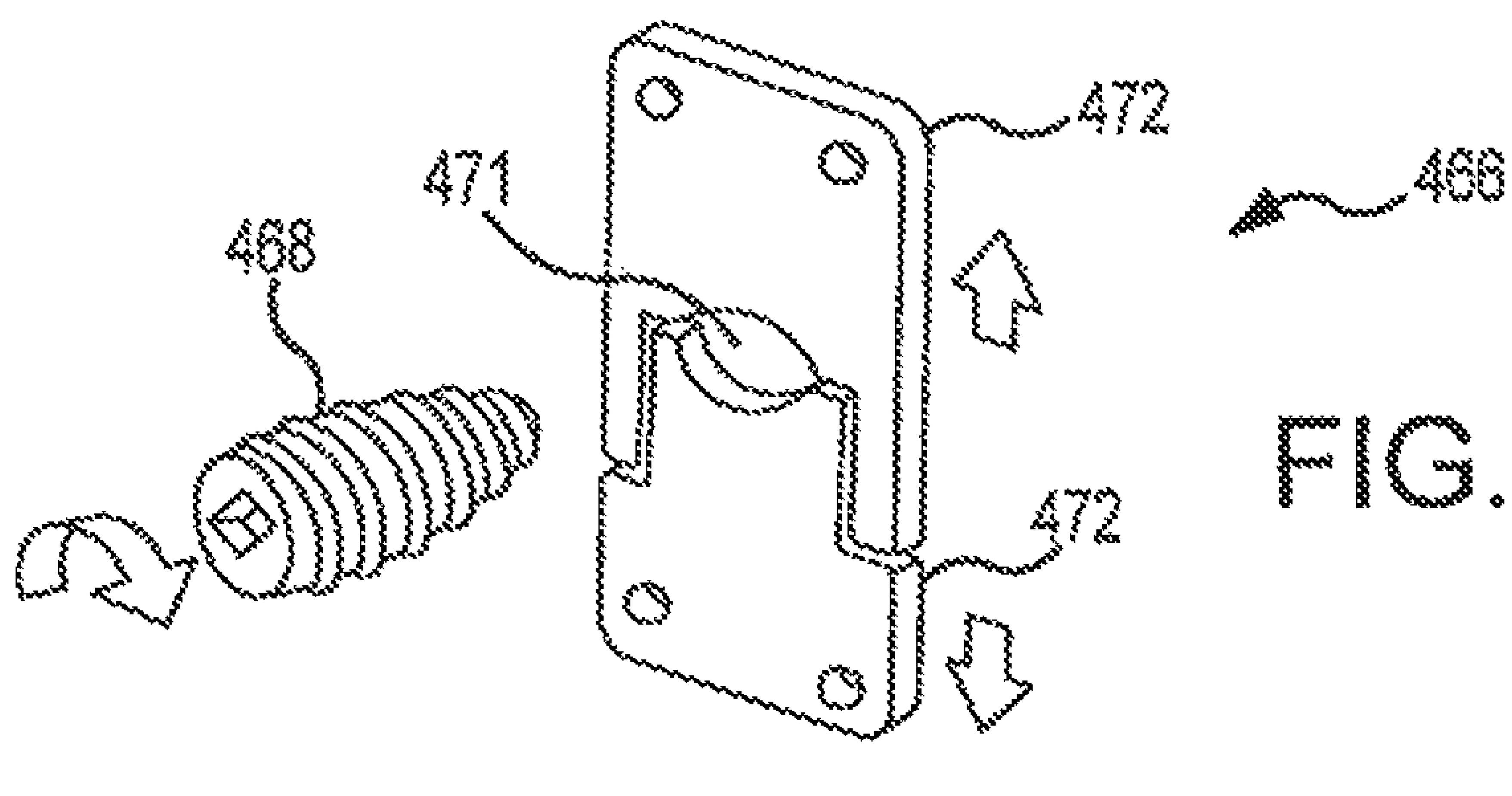


FIG.64C

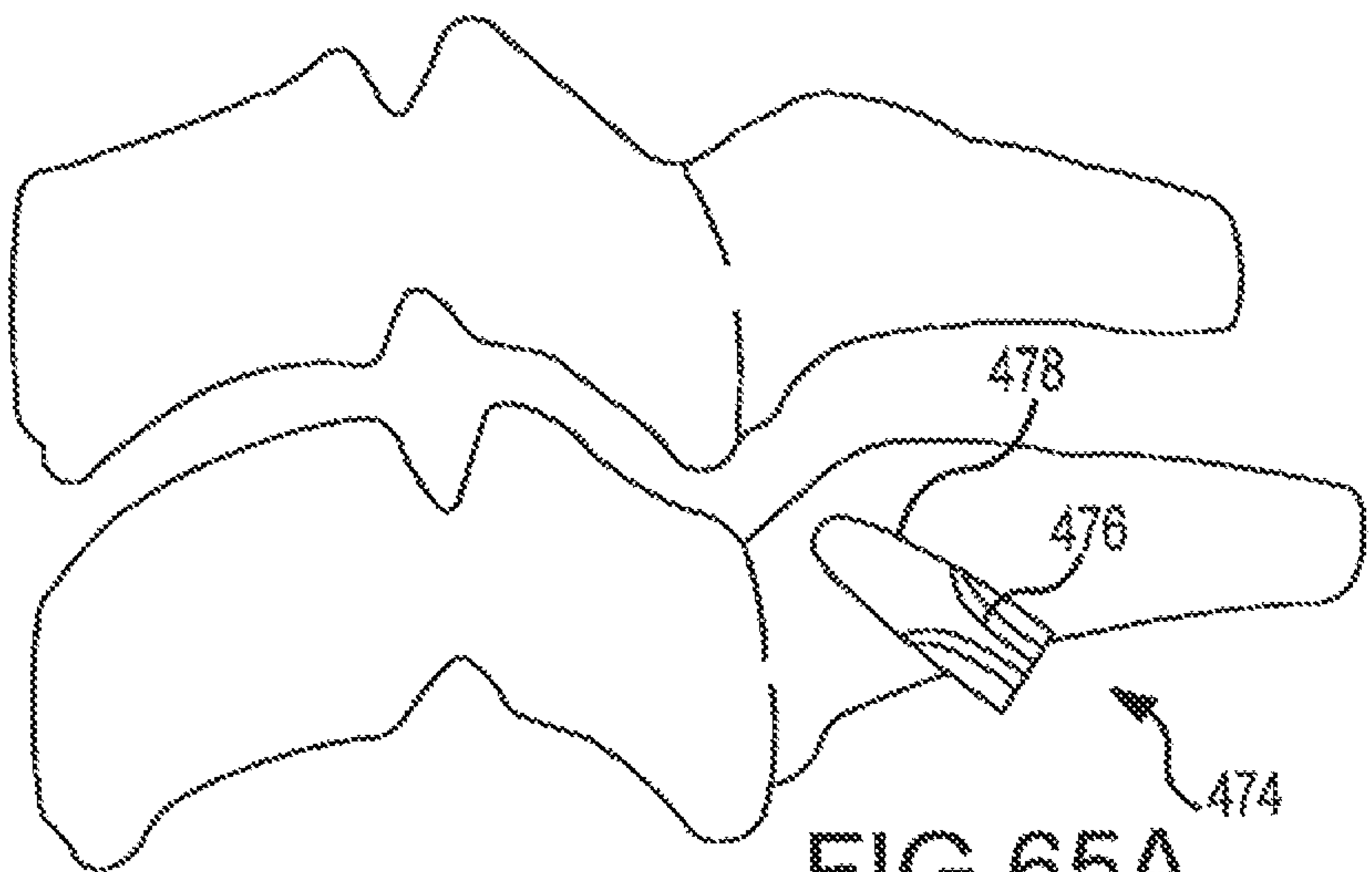


FIG.65A

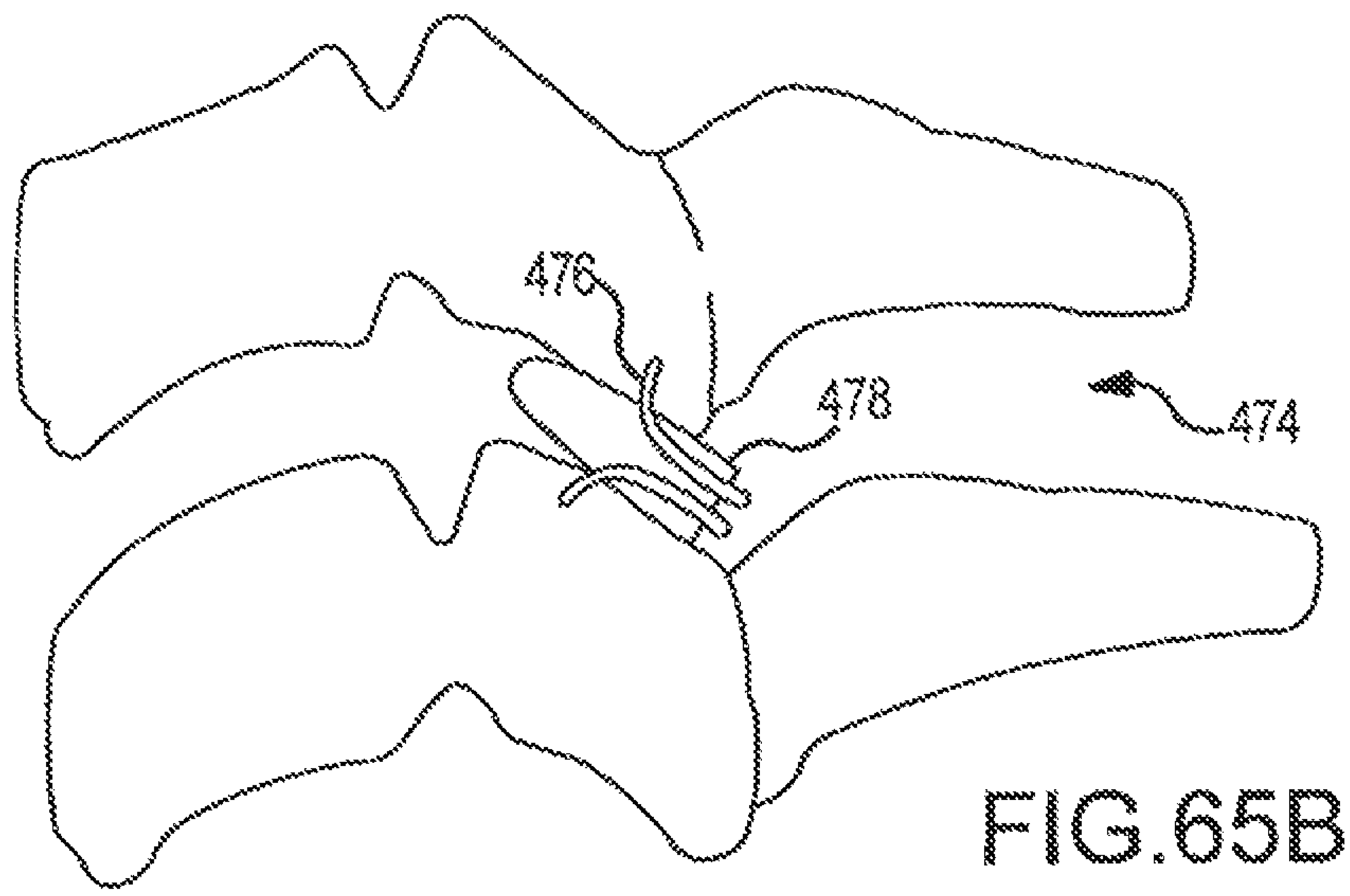


FIG.65B

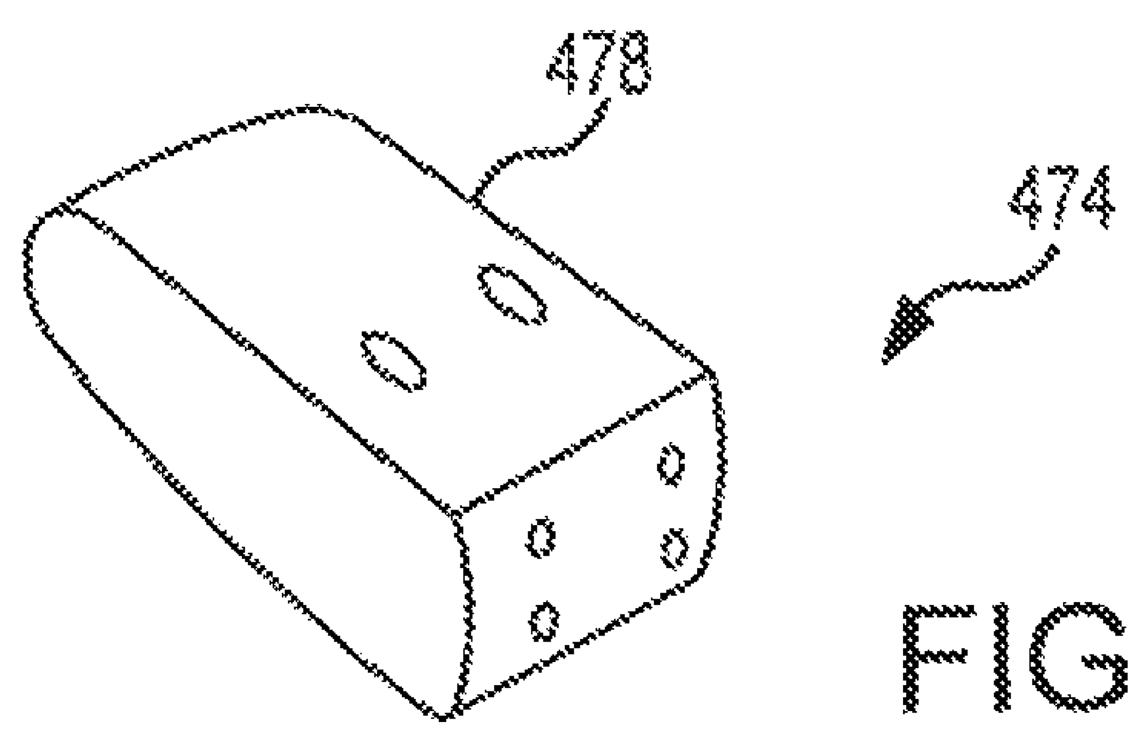


FIG.65C

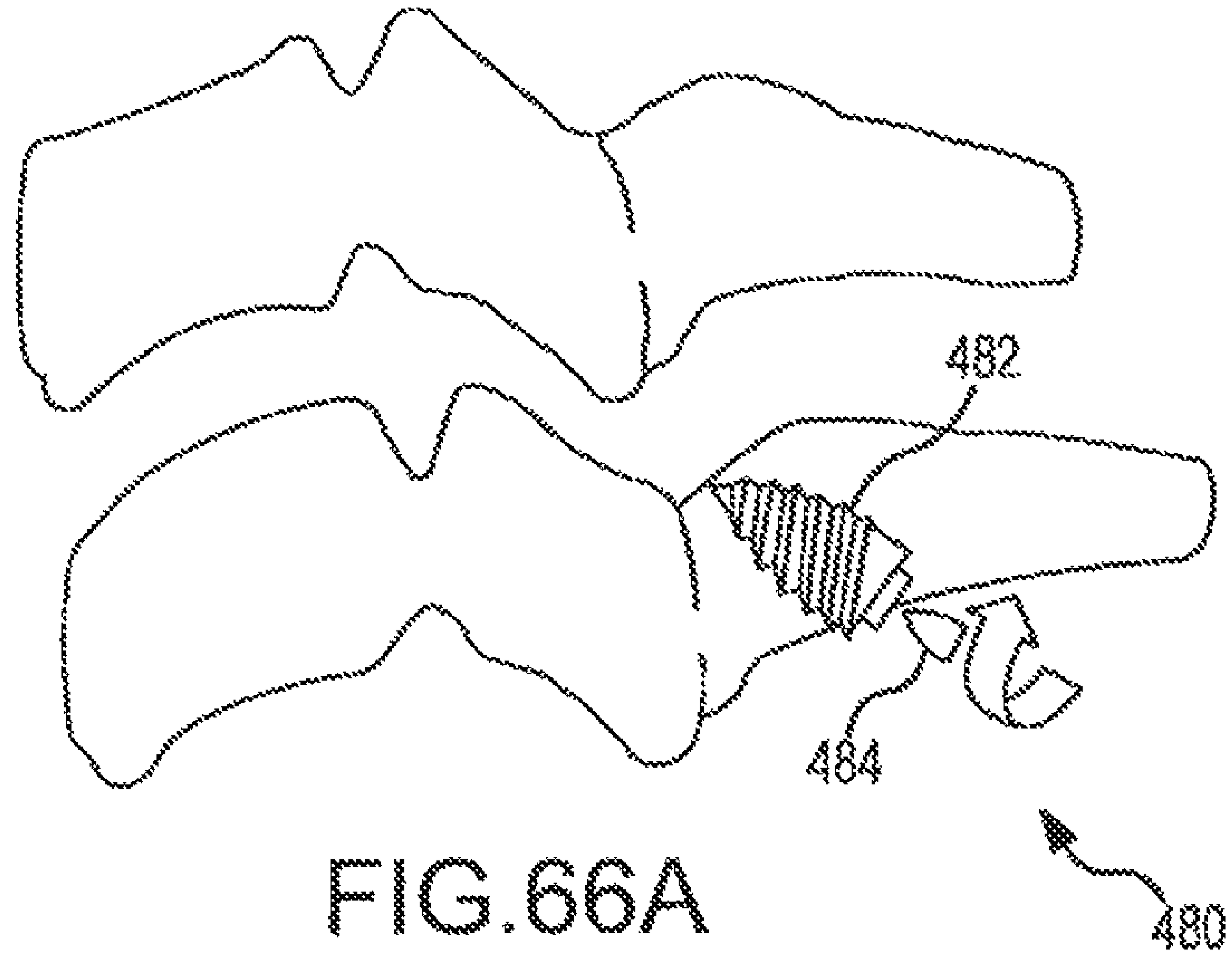


FIG.66A

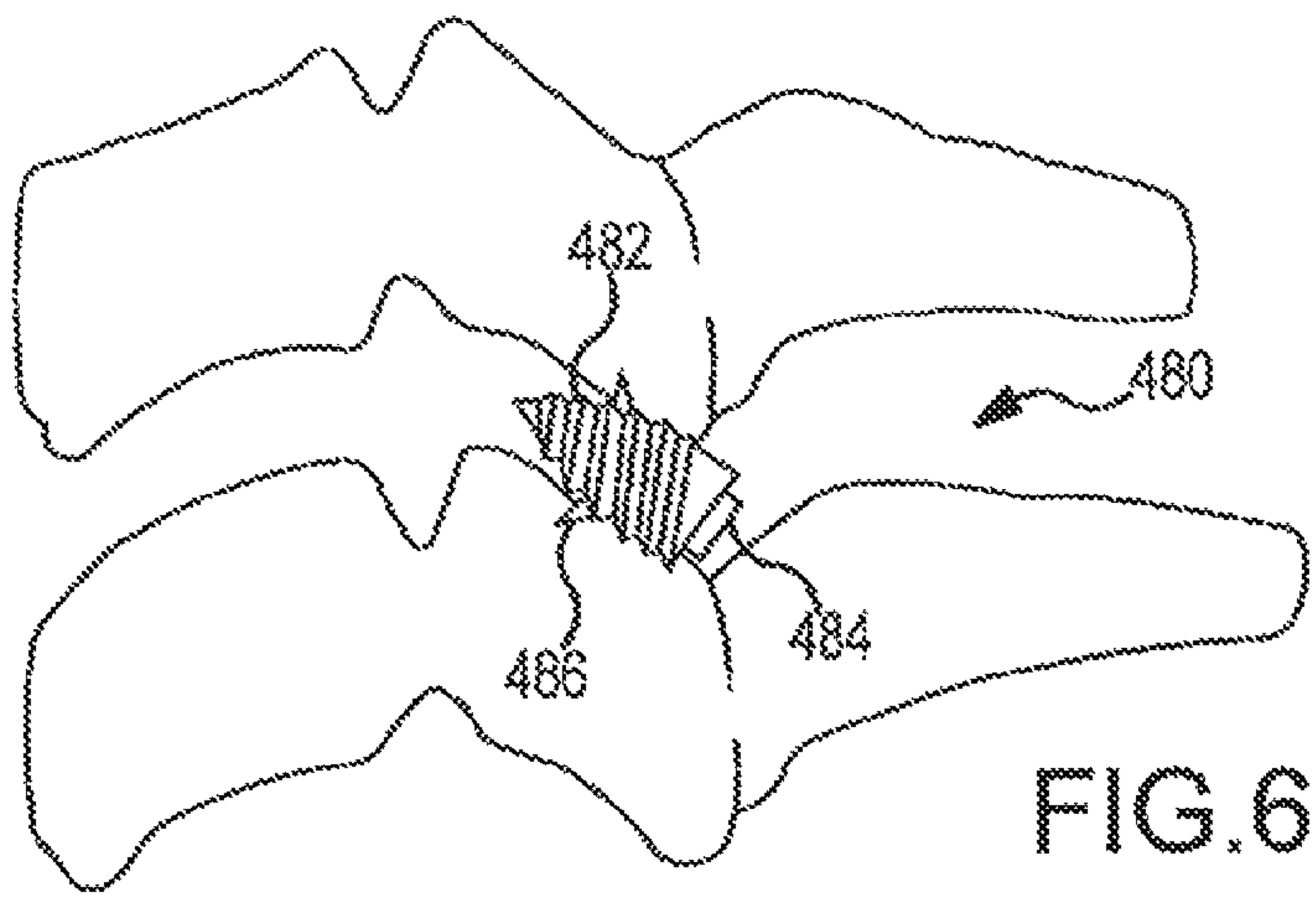


FIG.66B

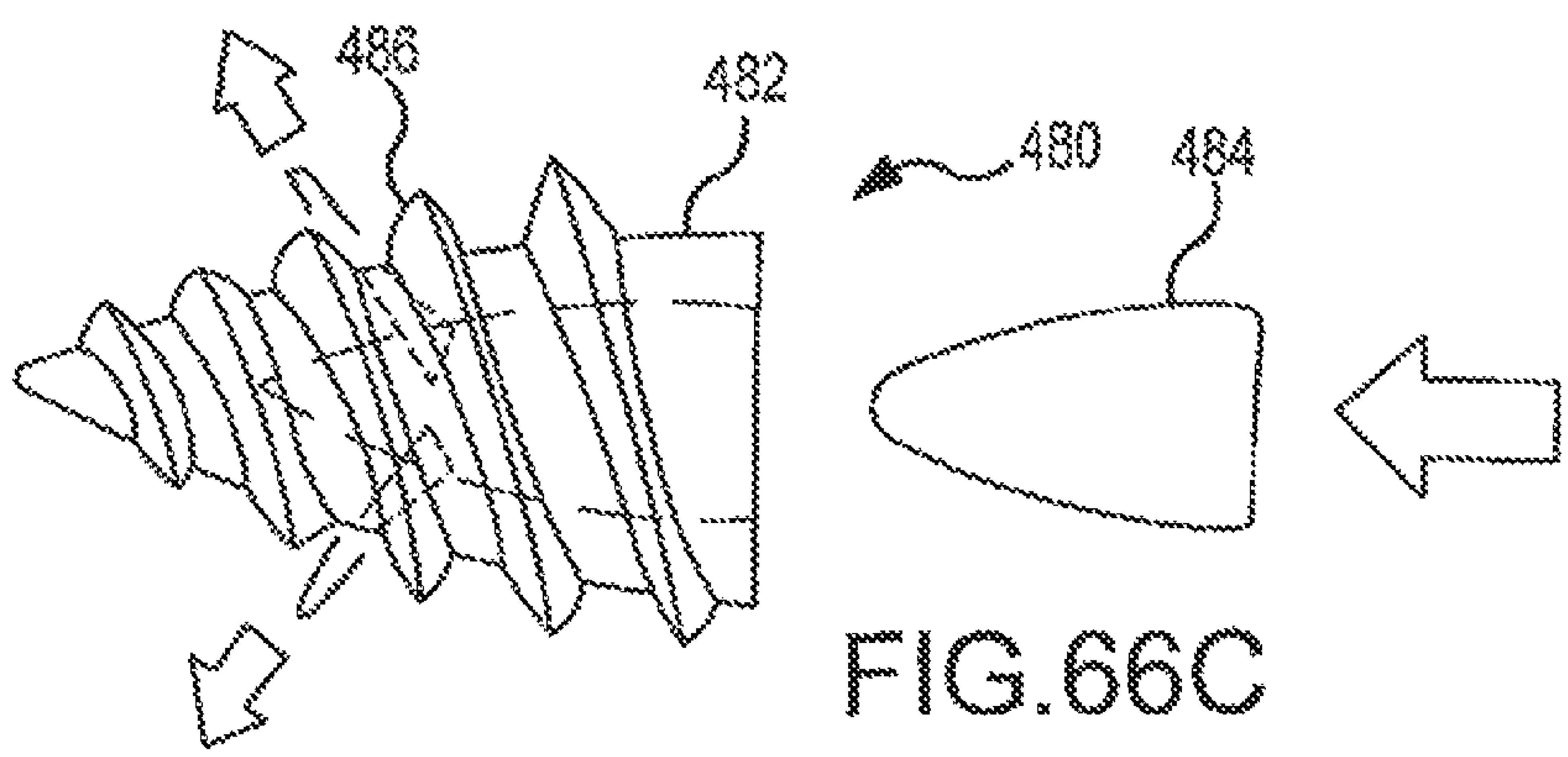


FIG.66C

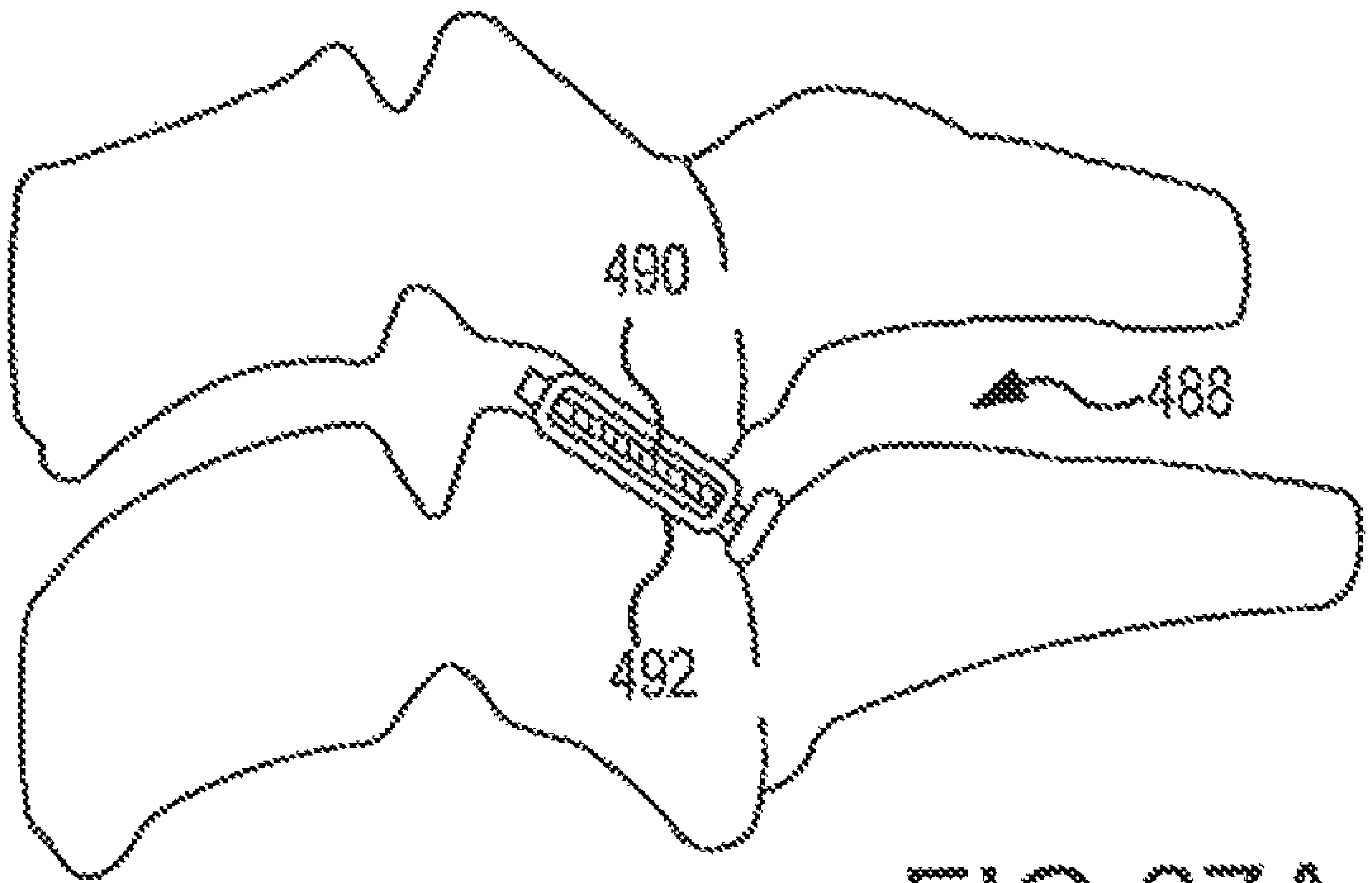


FIG.67A

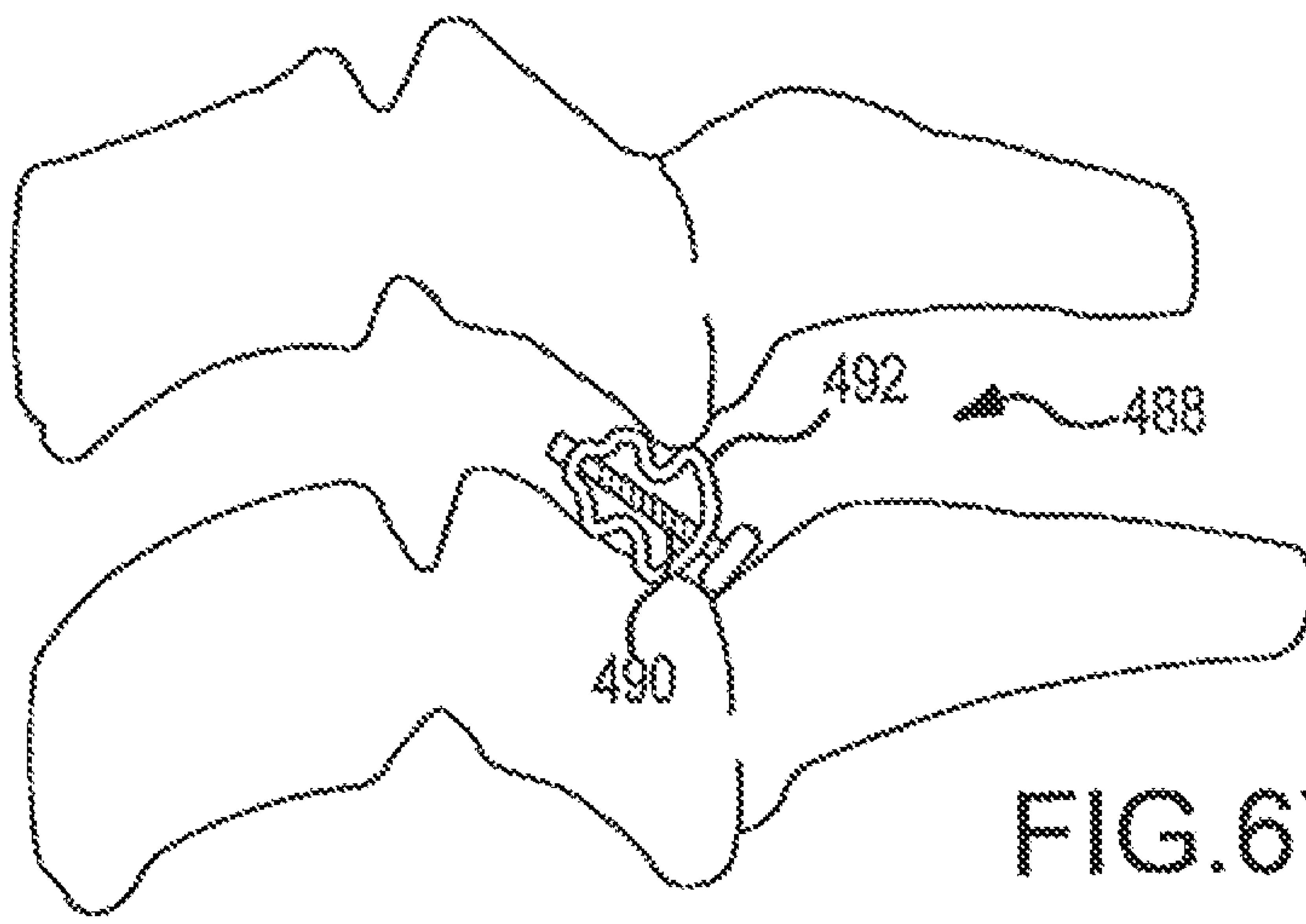


FIG.67B

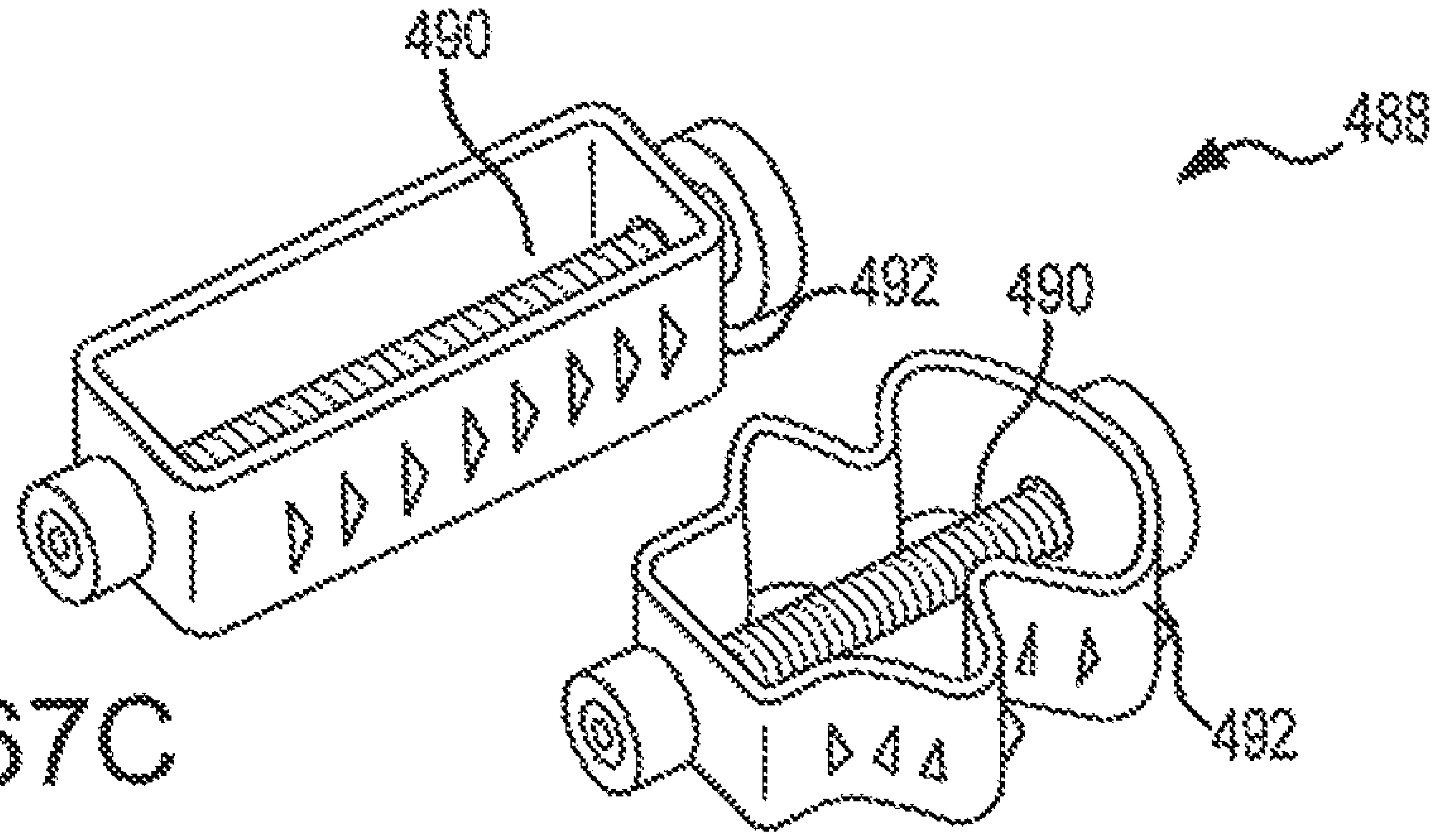


FIG.67C

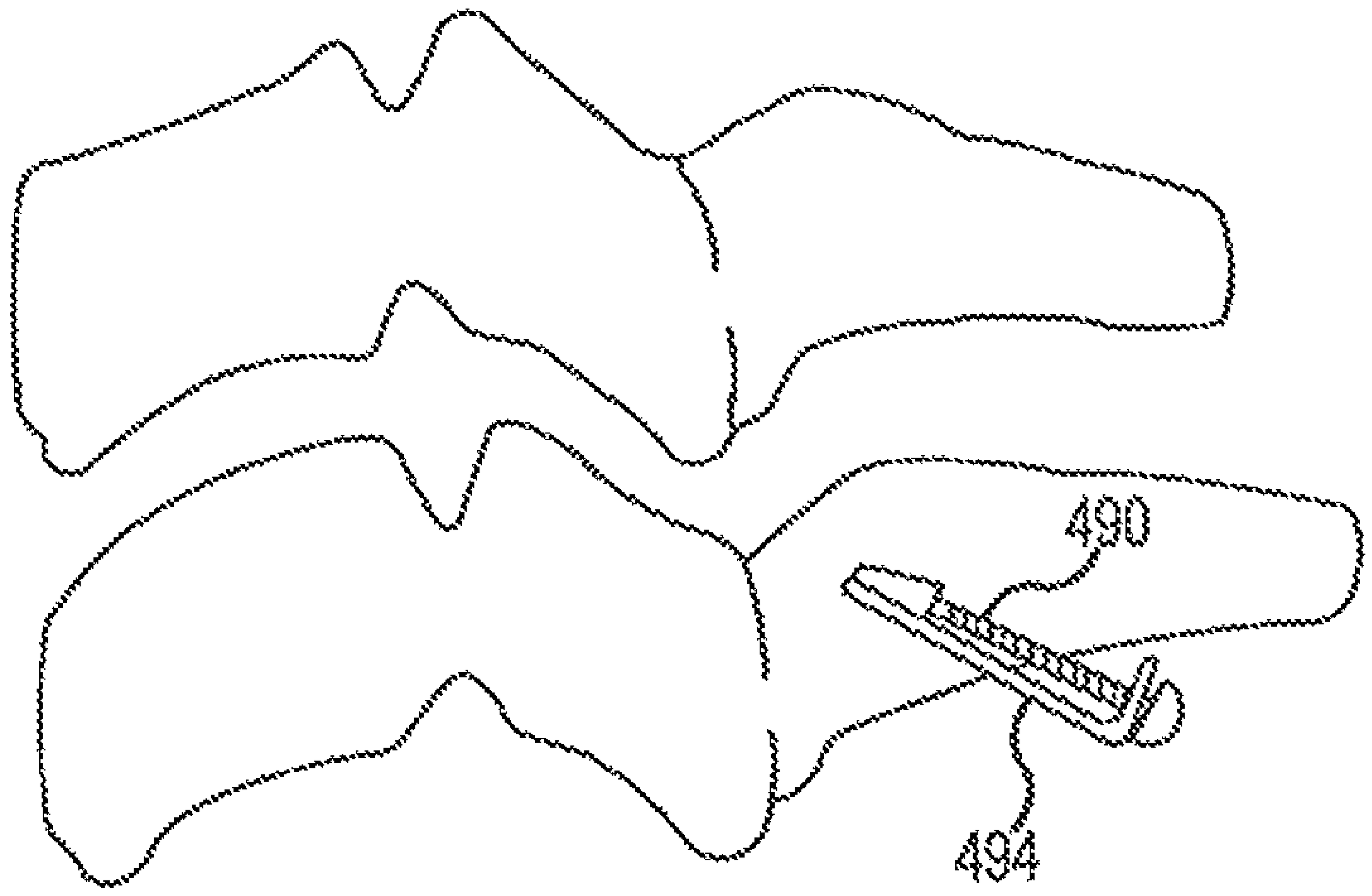


FIG.68A

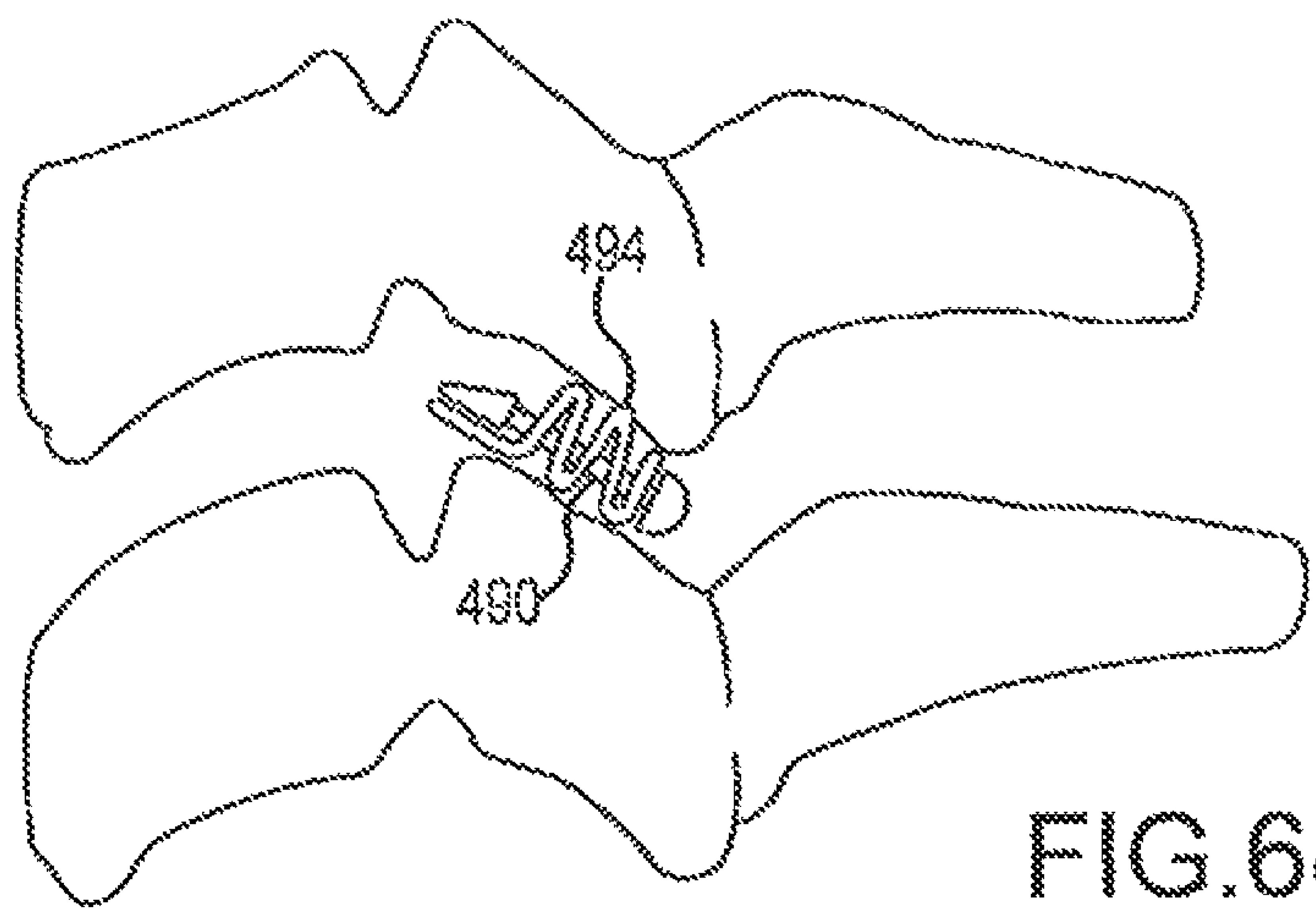


FIG.68B

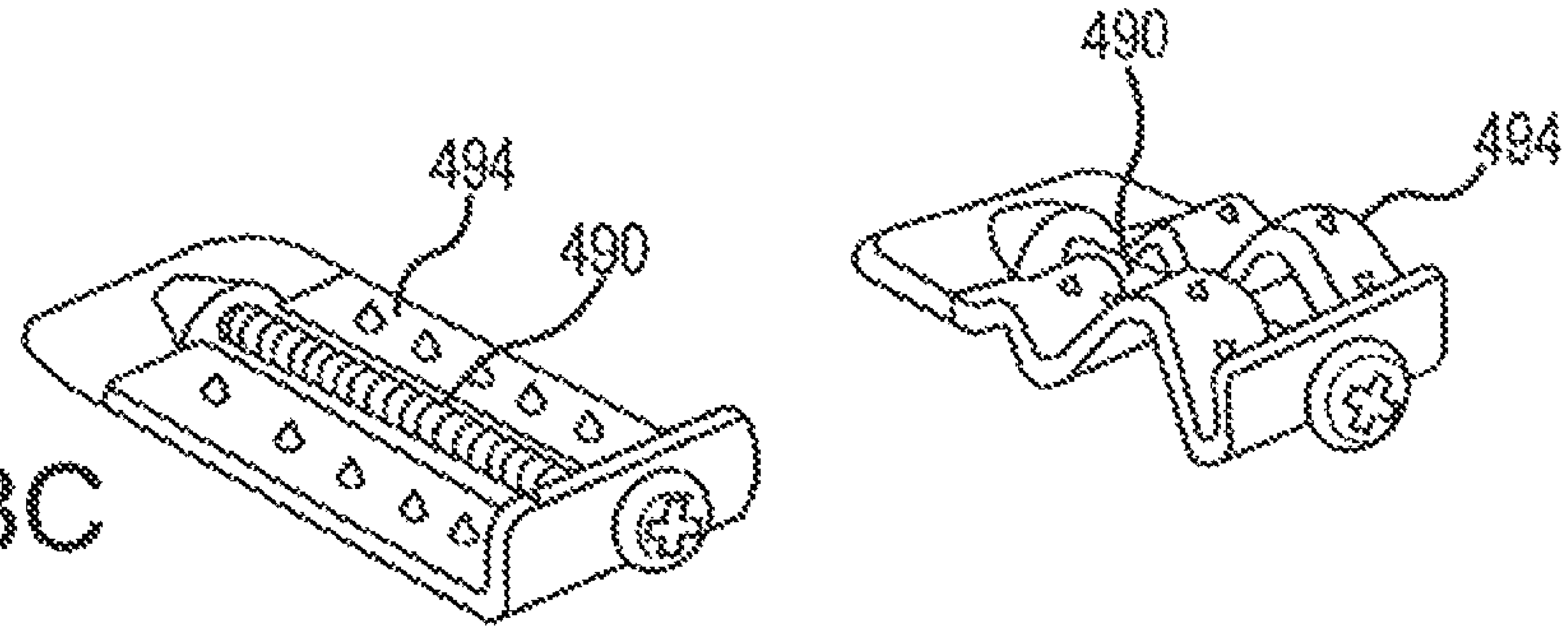


FIG.68C

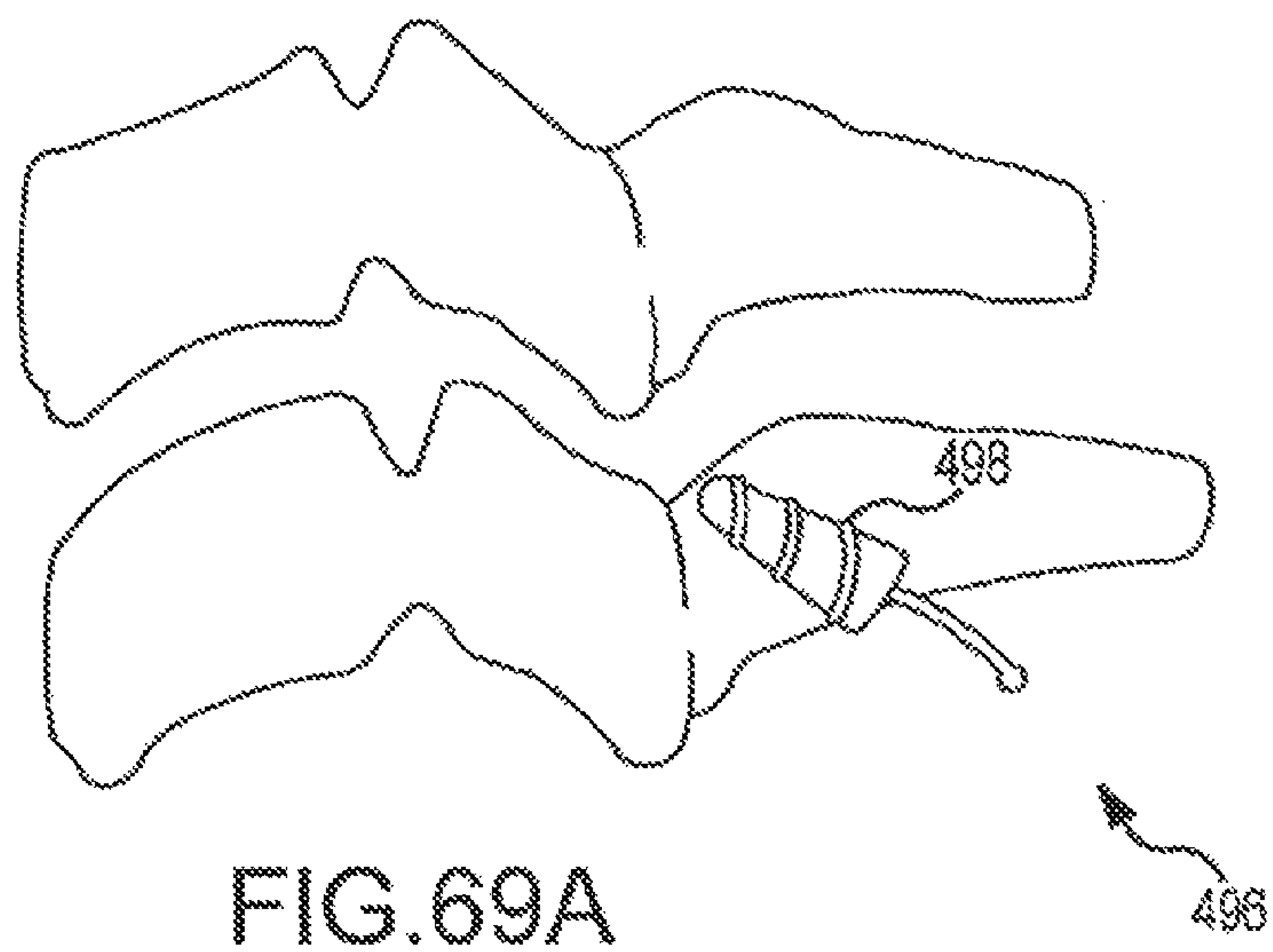


FIG.69A

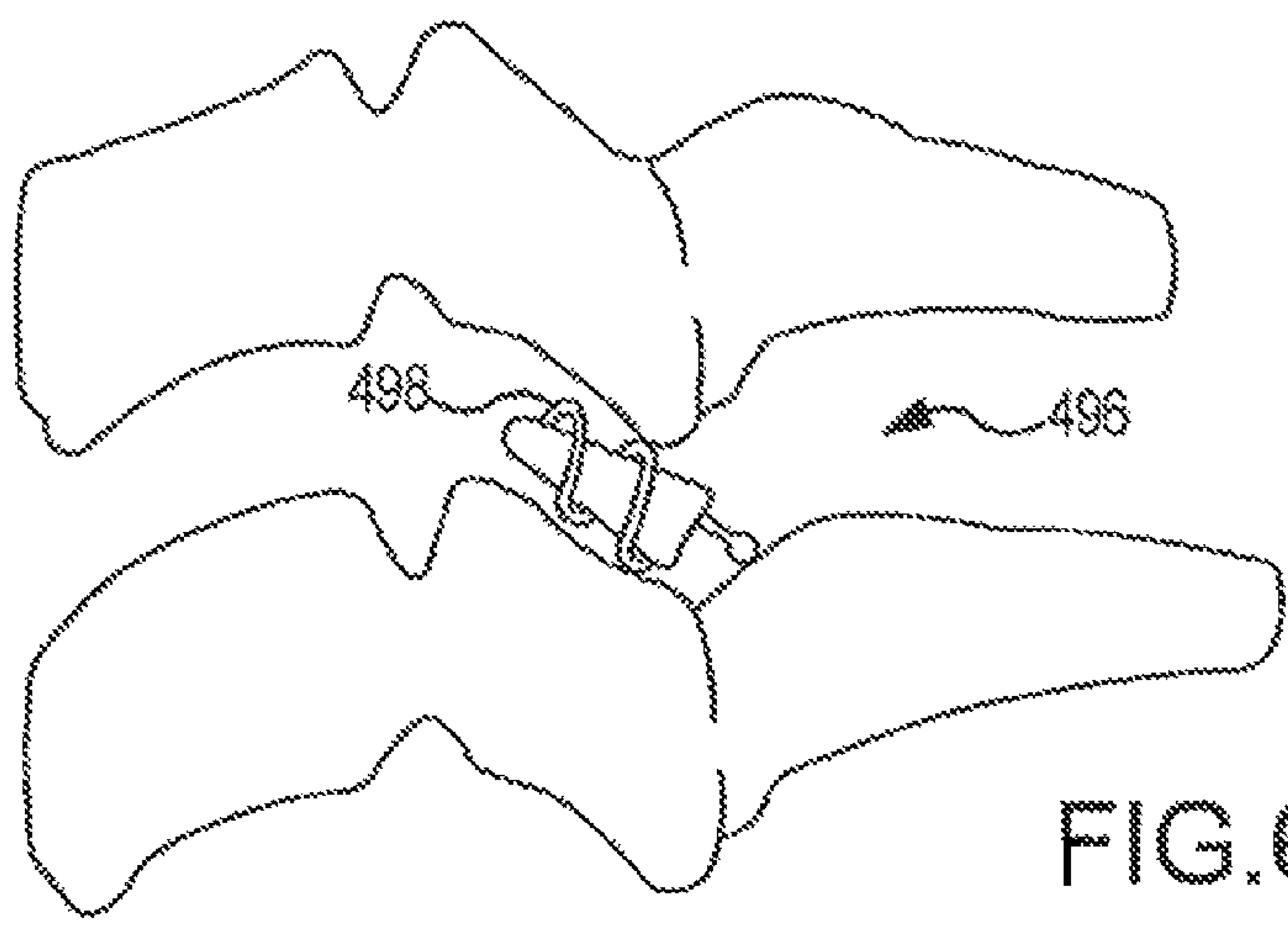


FIG.69B

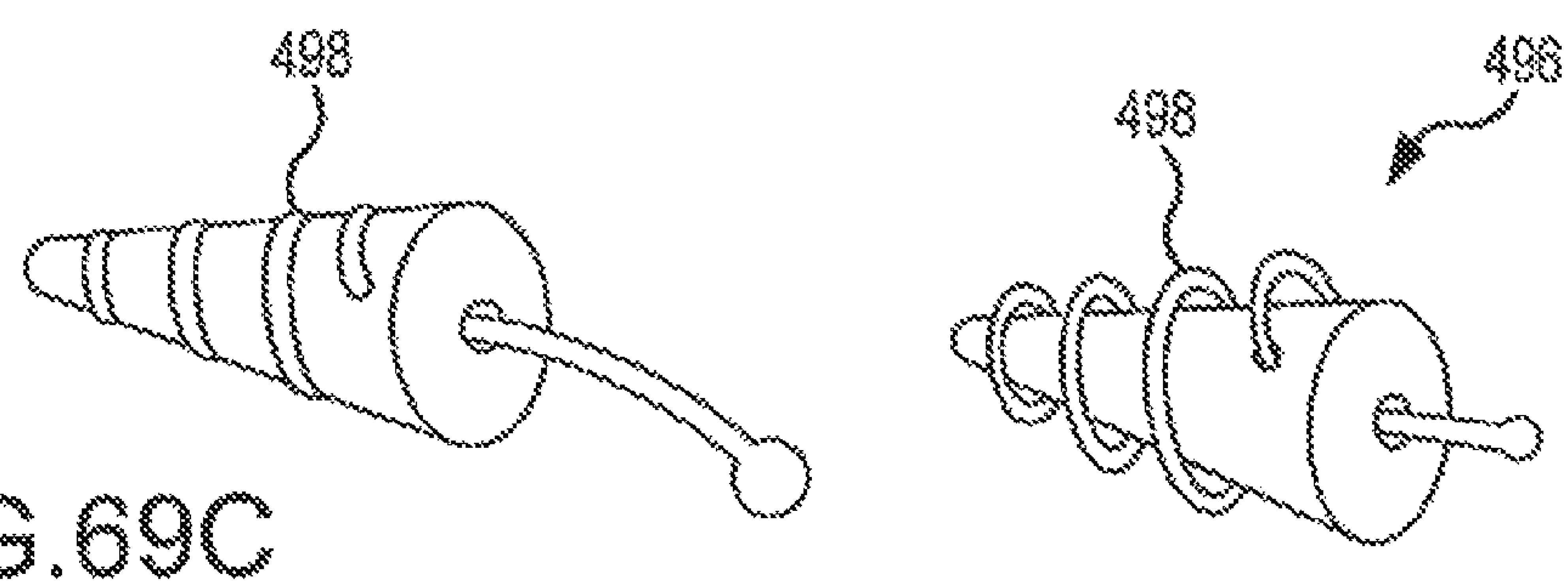


FIG.69C

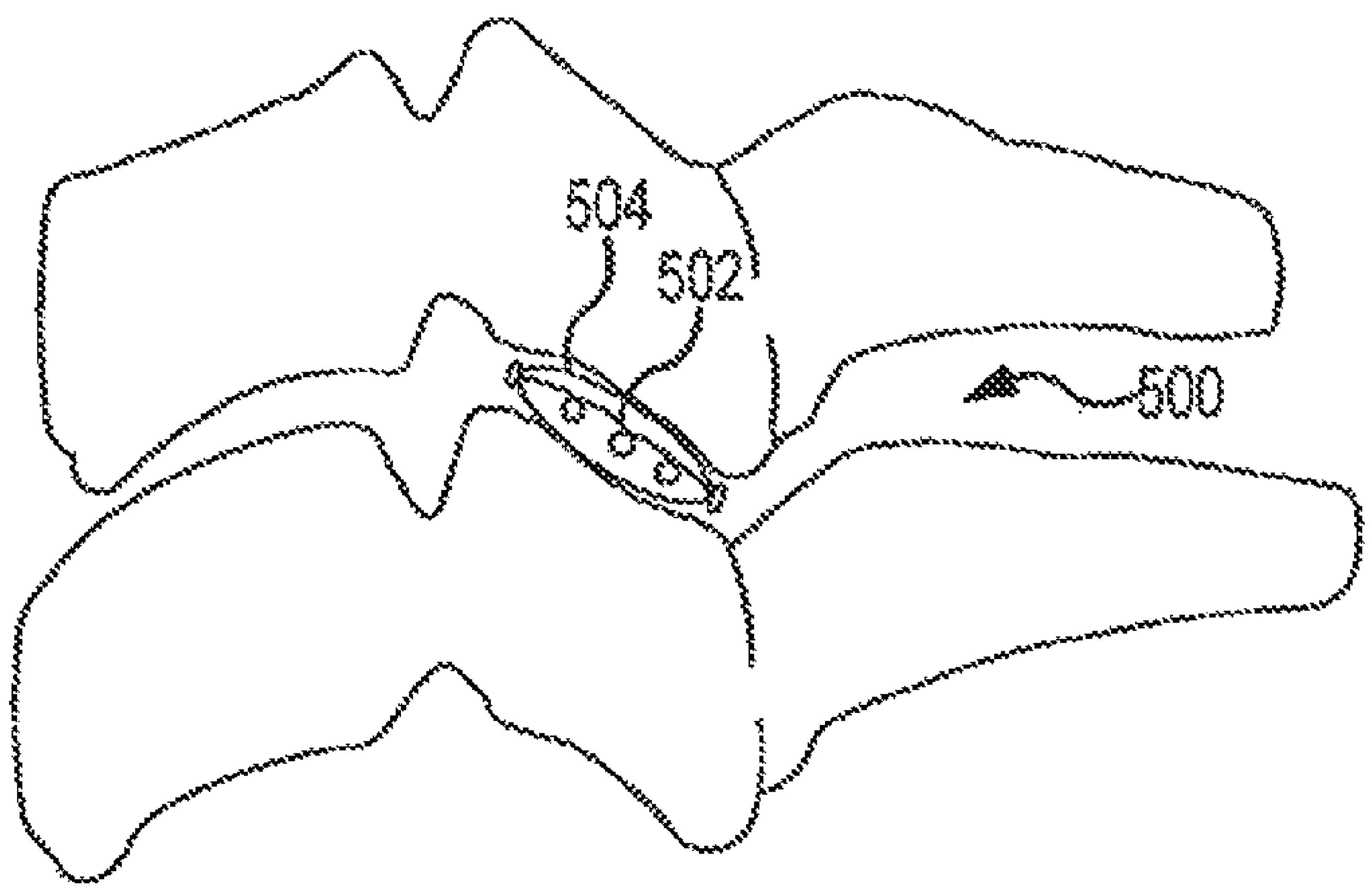


FIG.70A

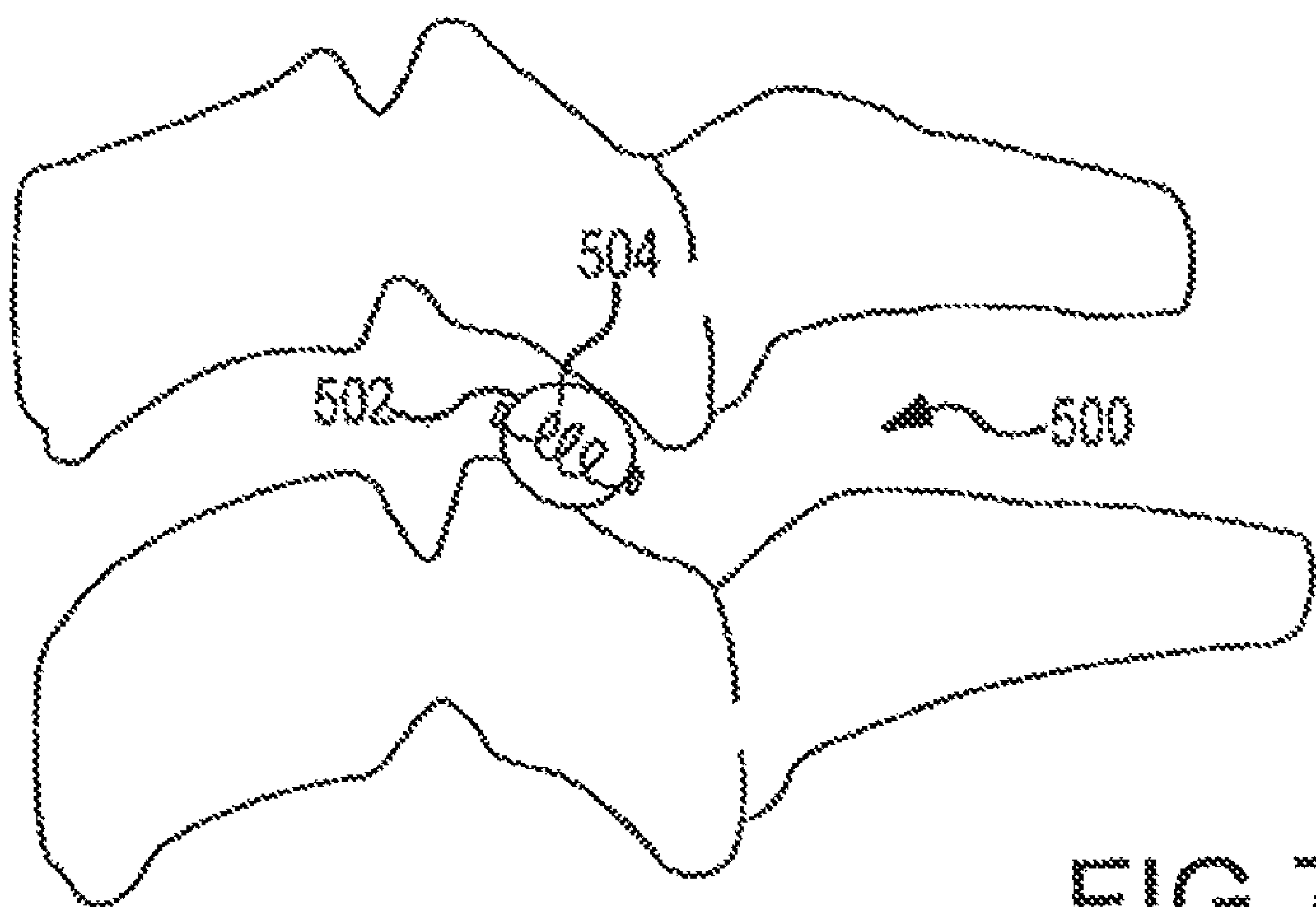


FIG.70B

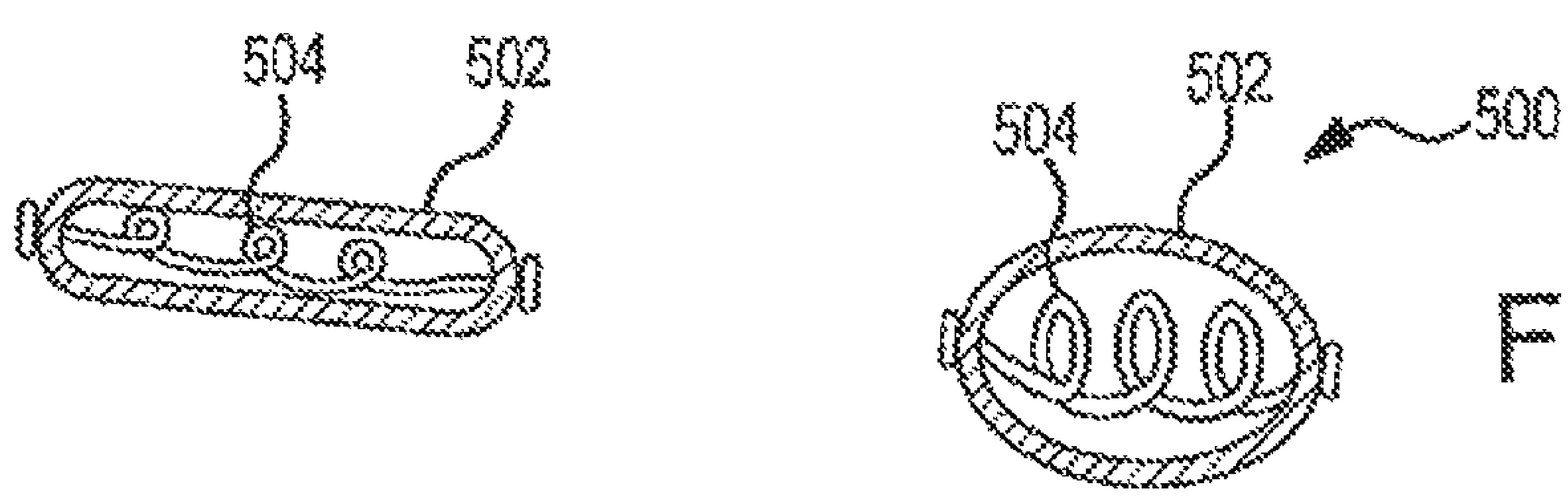


FIG.70C

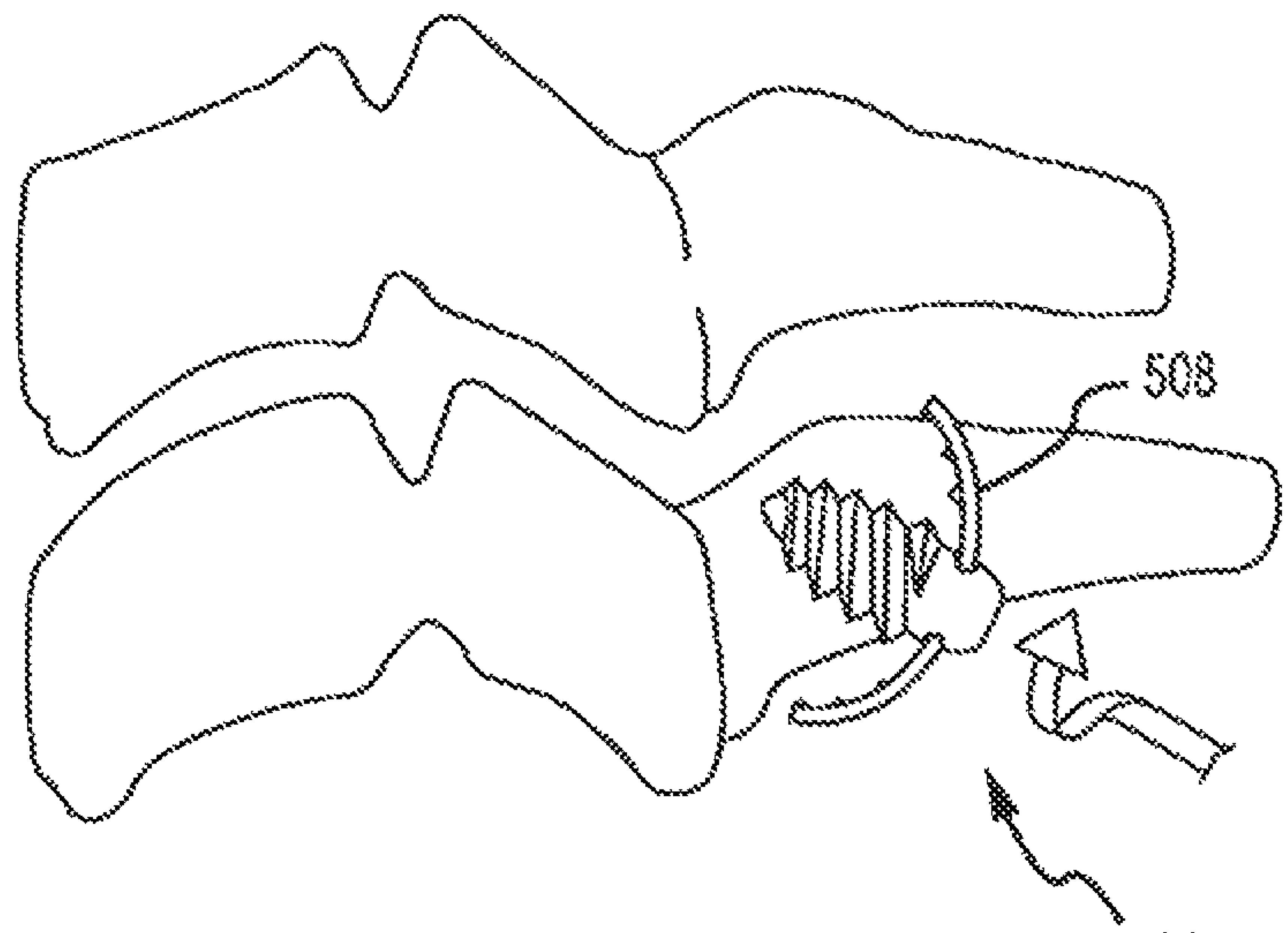


FIG.71A

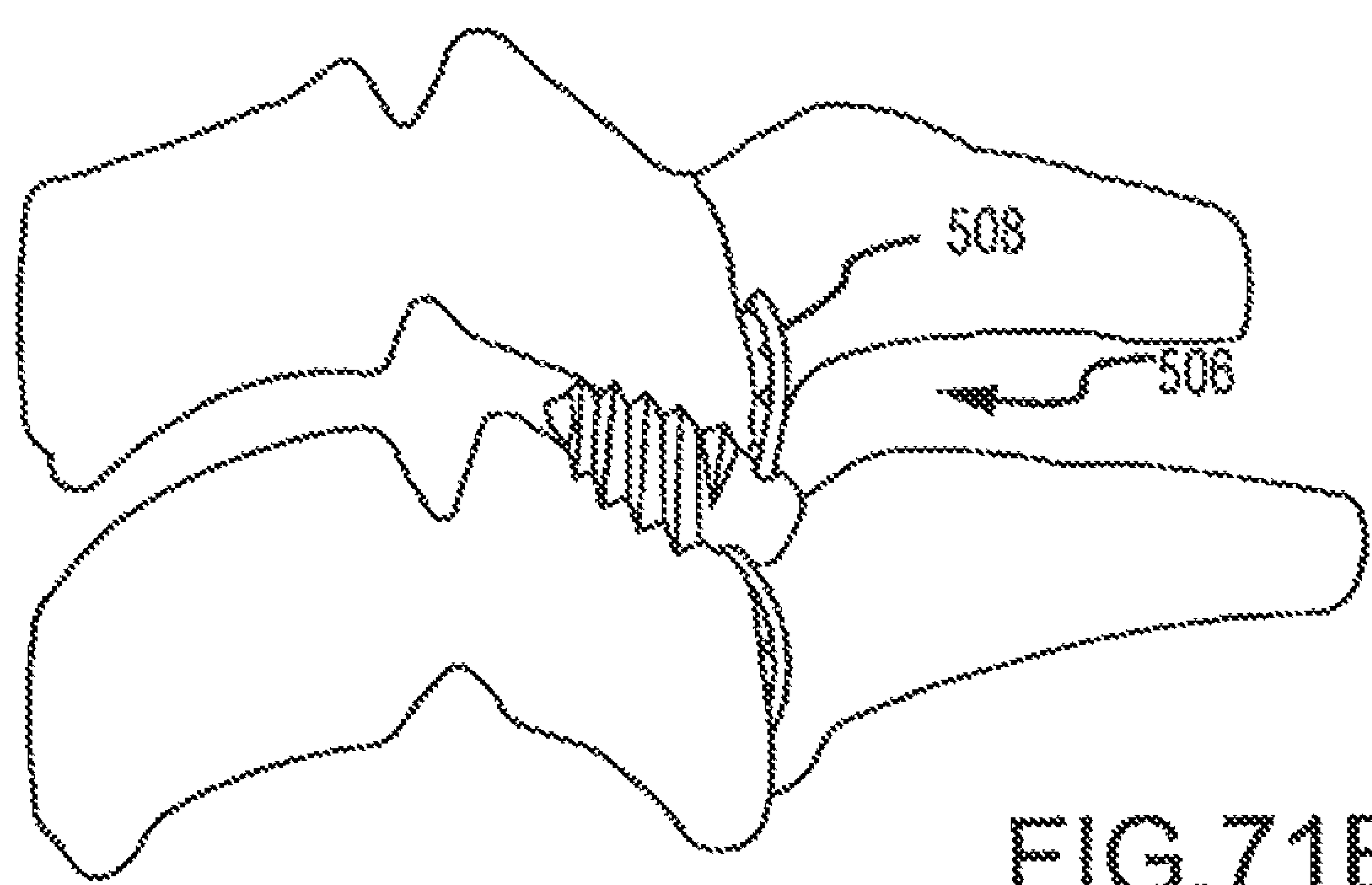


FIG.71B

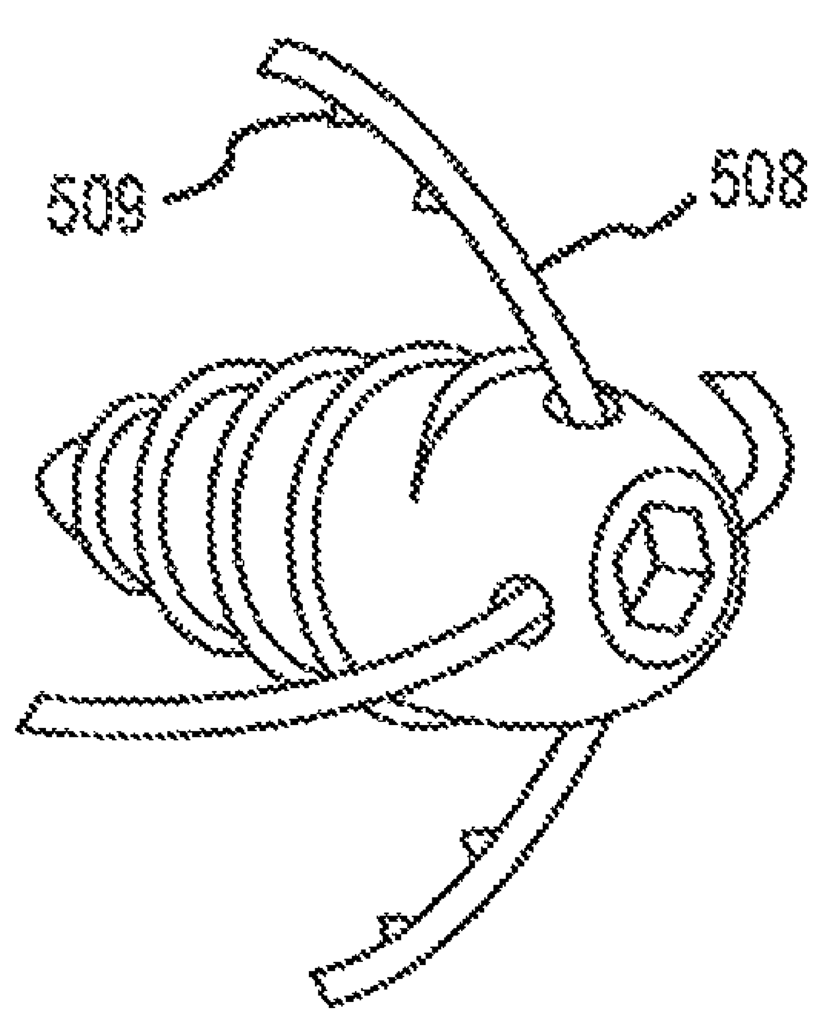


FIG.71C

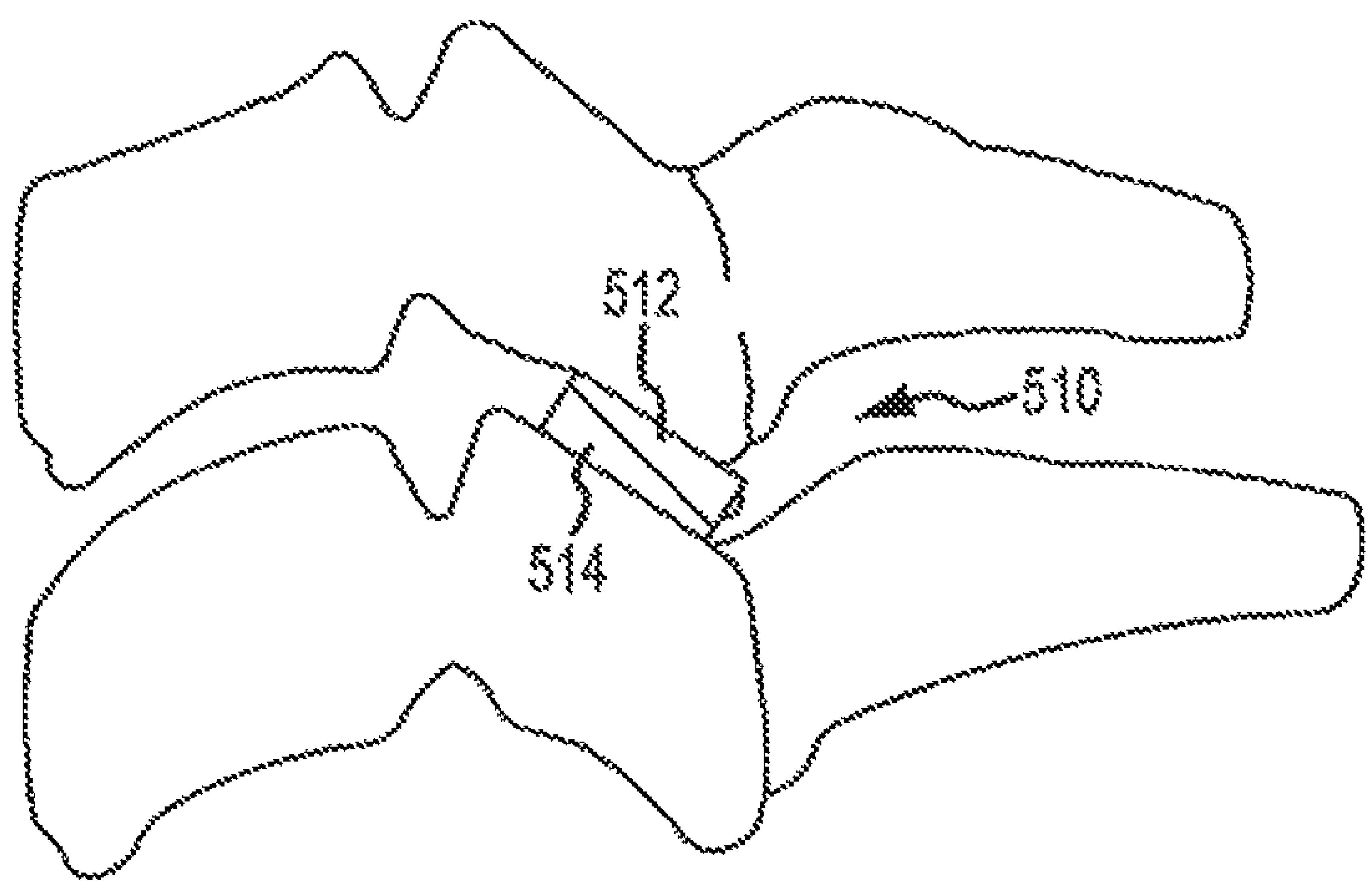


FIG.72A

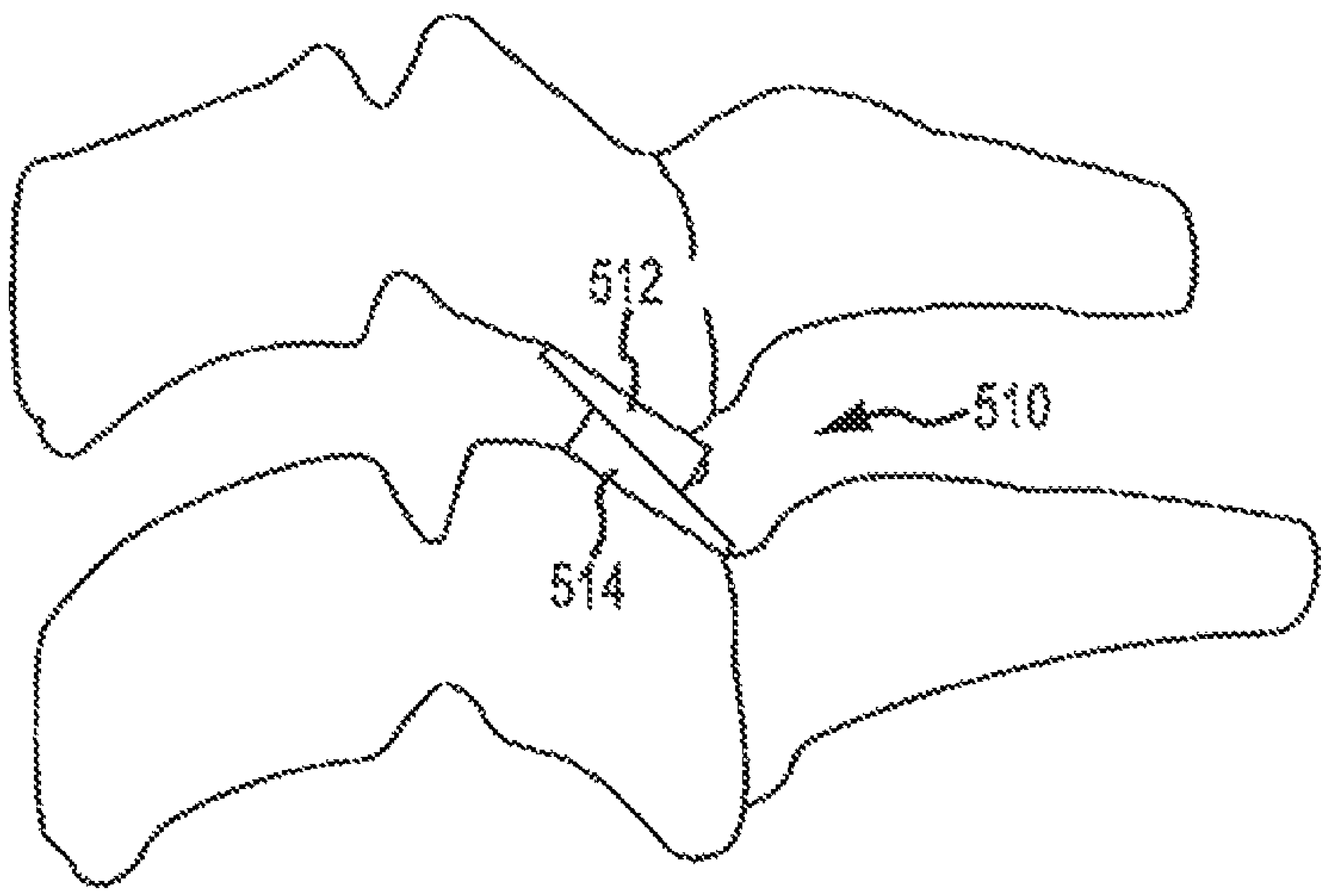


FIG.72B

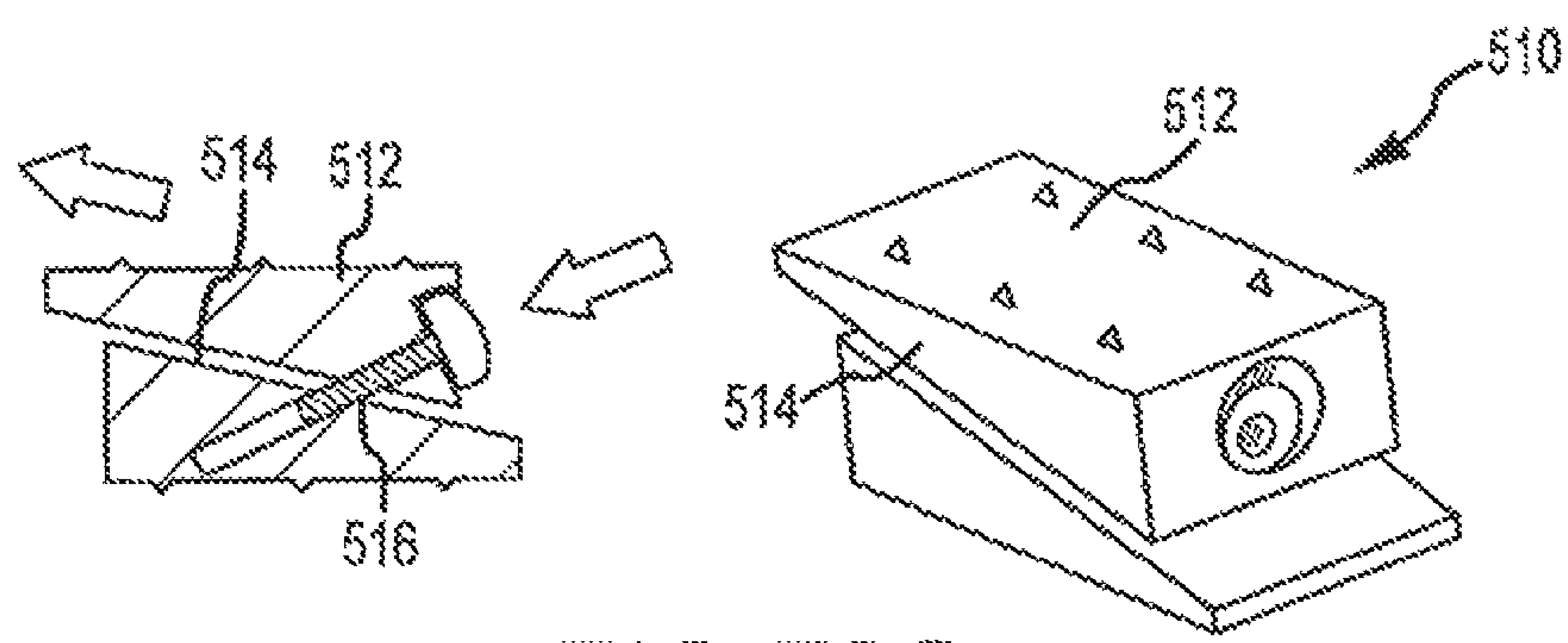


FIG.72C

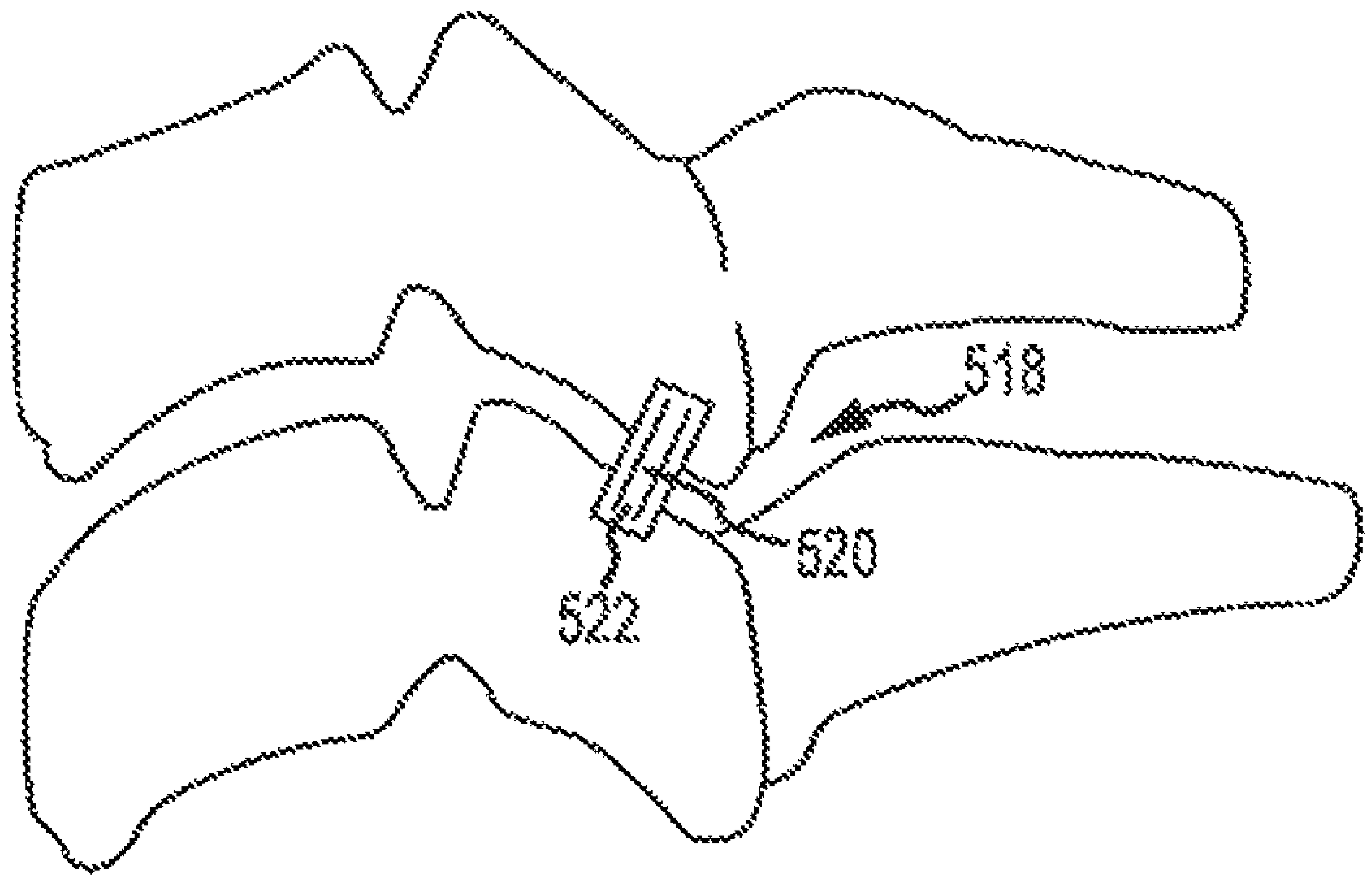


FIG.73A

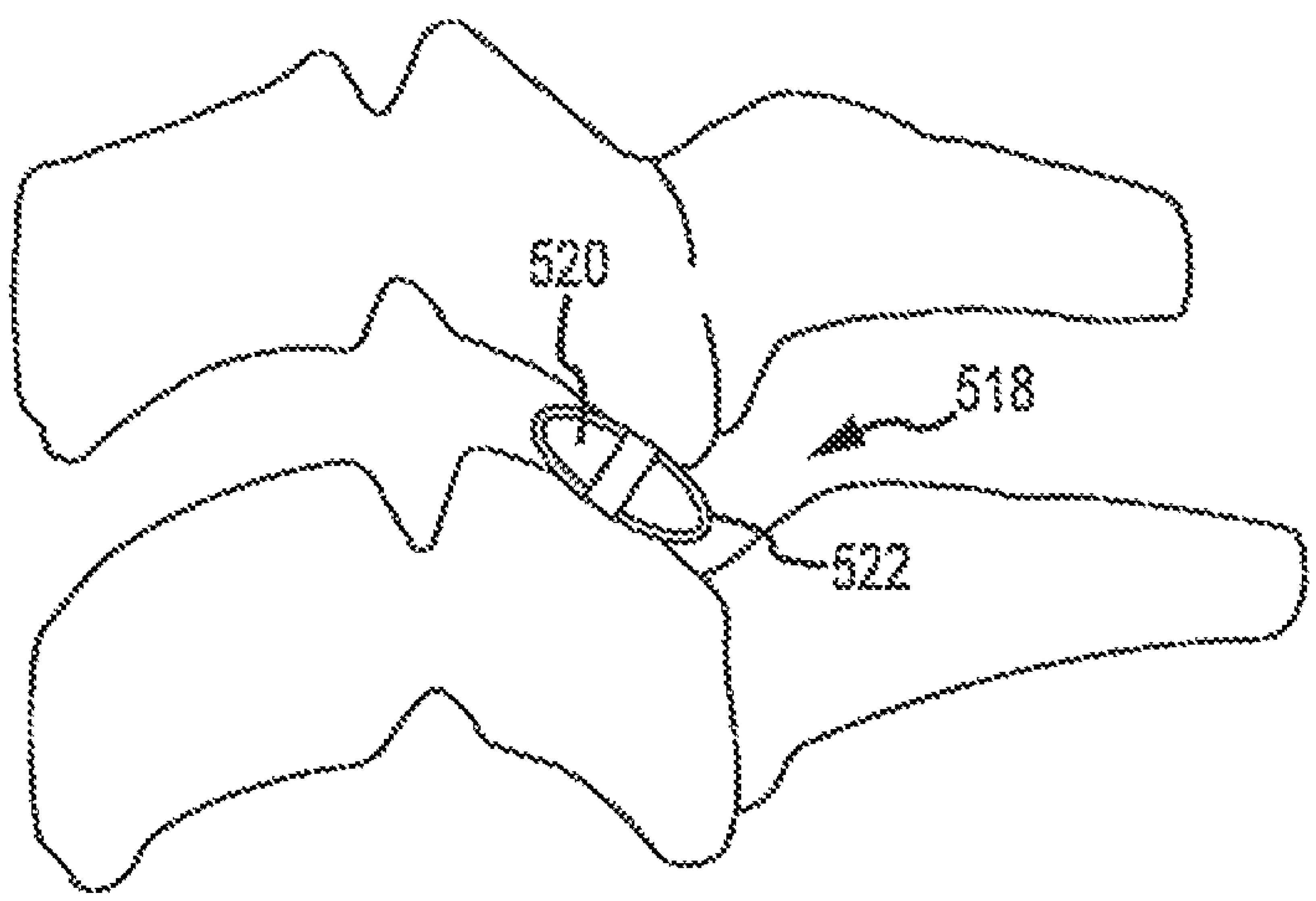


FIG.73B

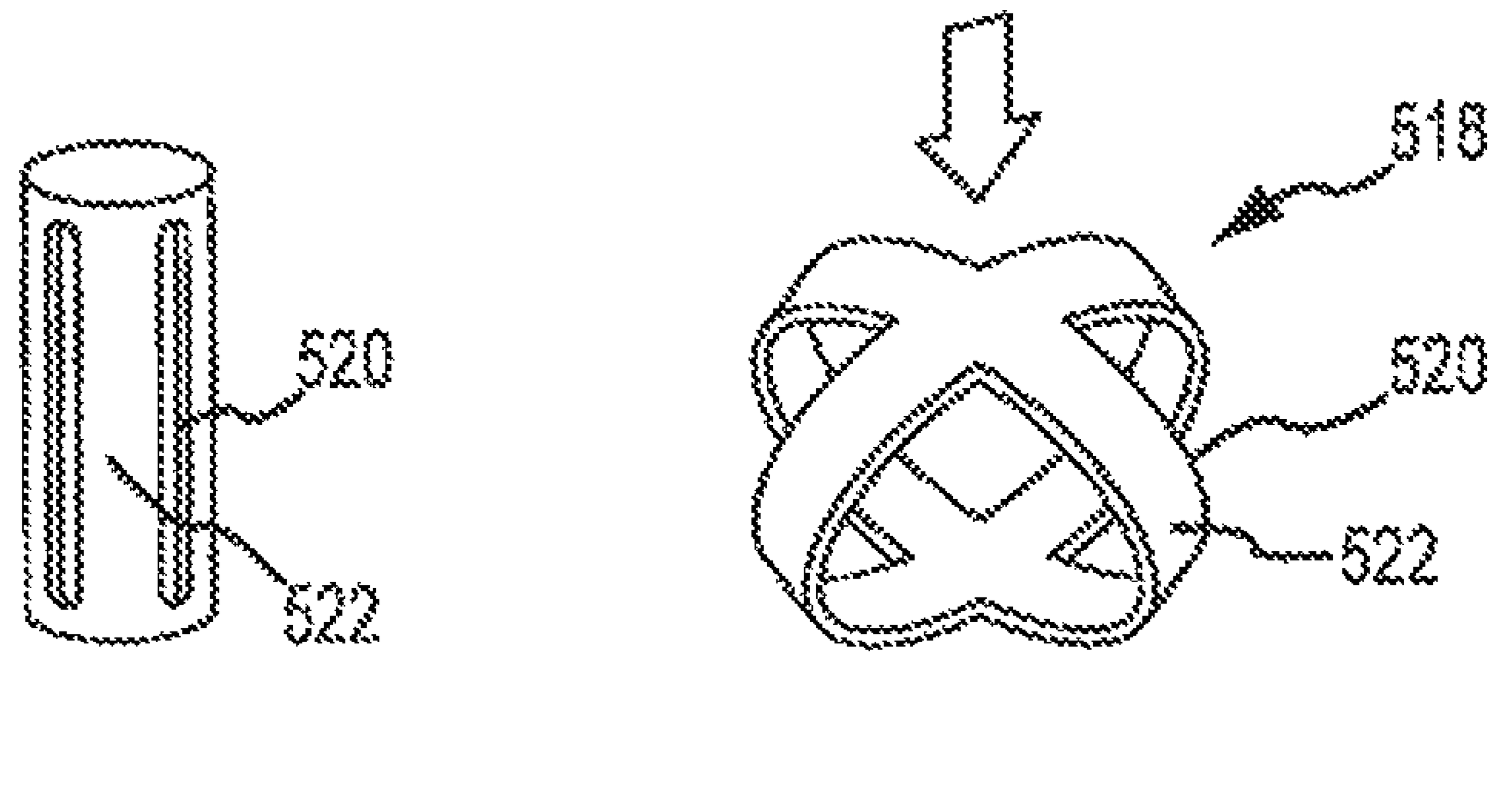


FIG.73C

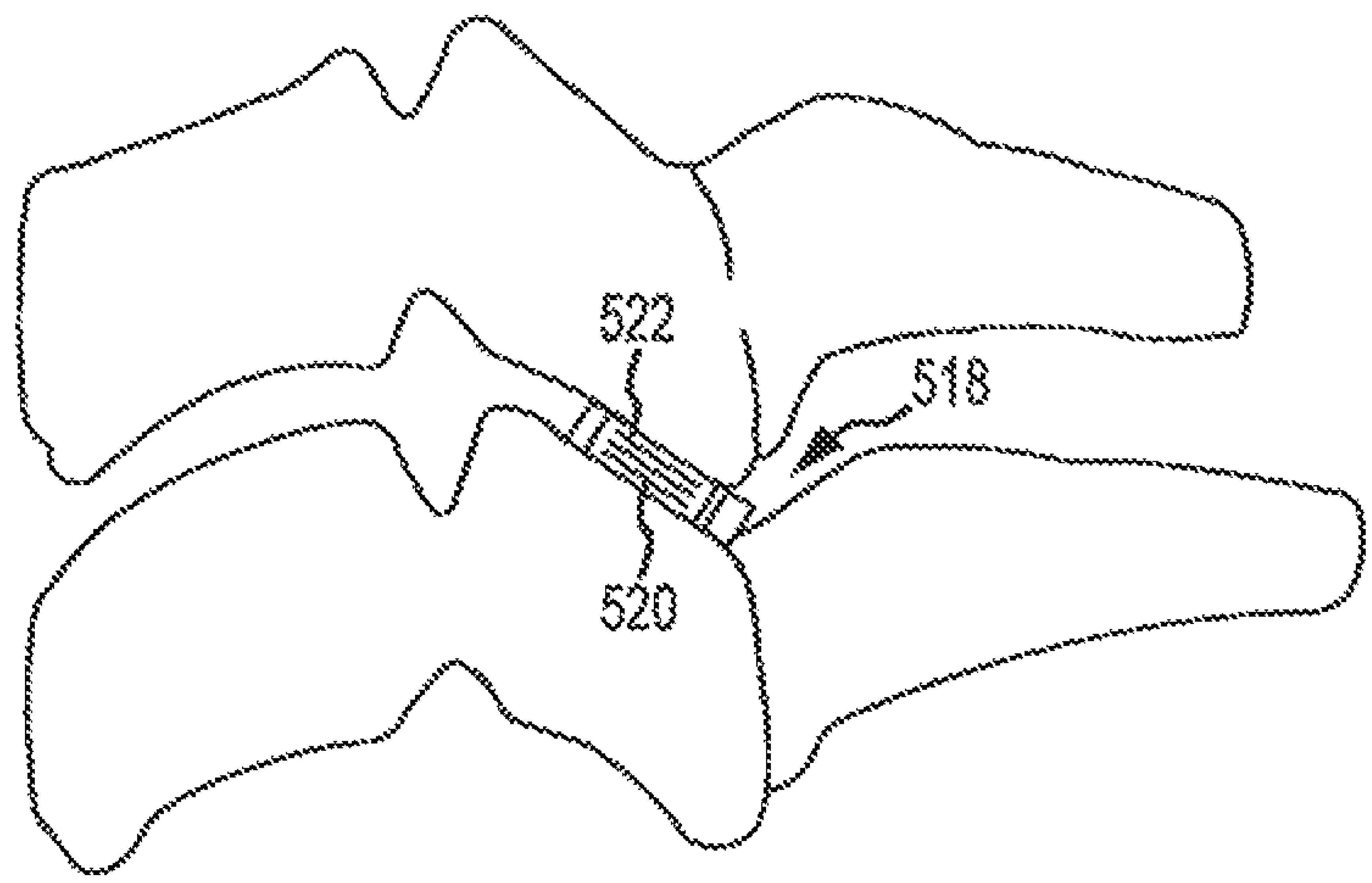


FIG.74A

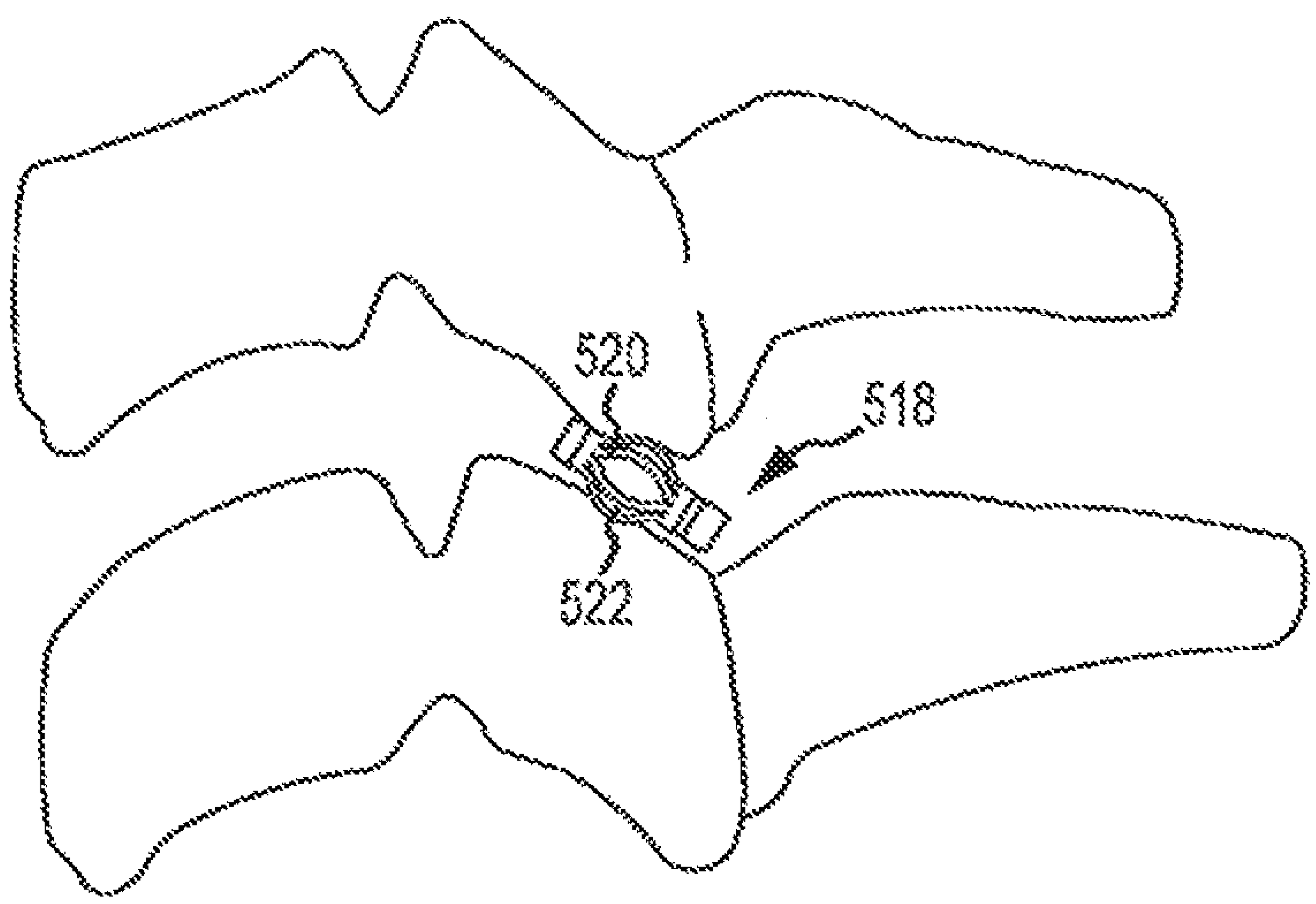


FIG.74B

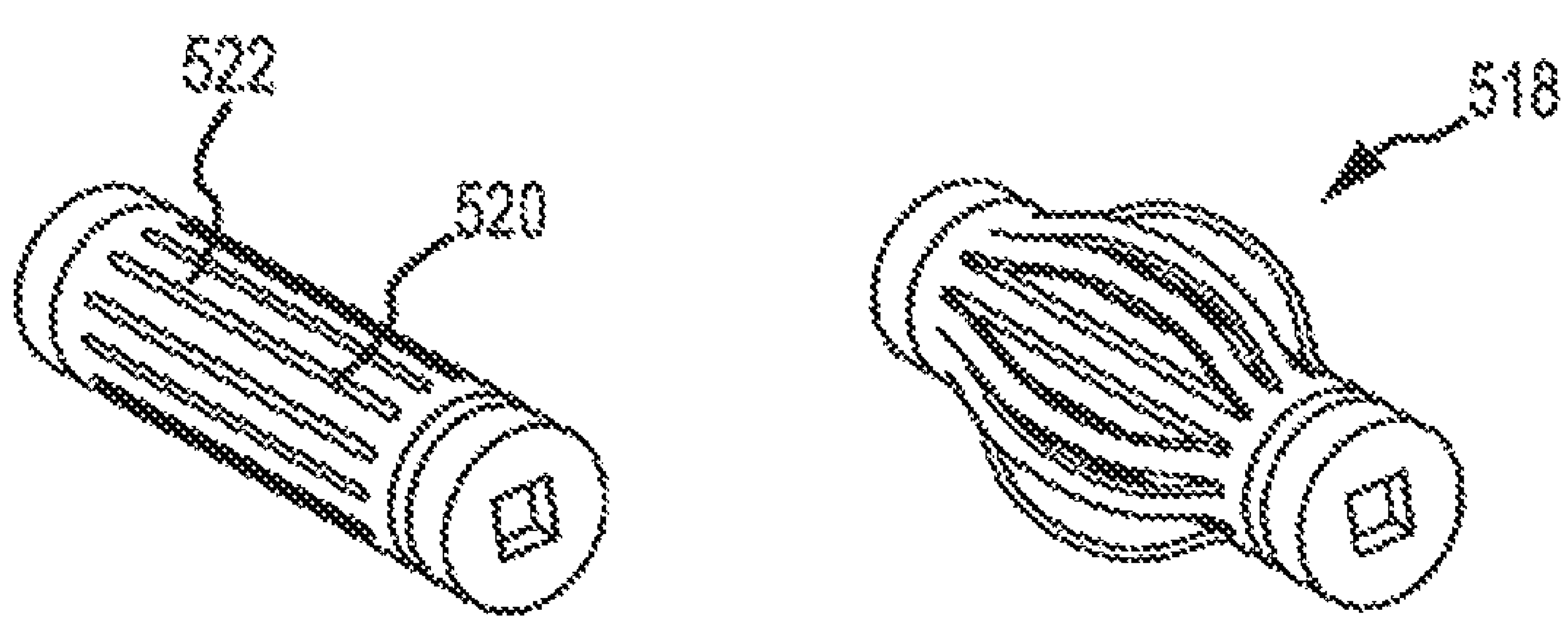


FIG.74C

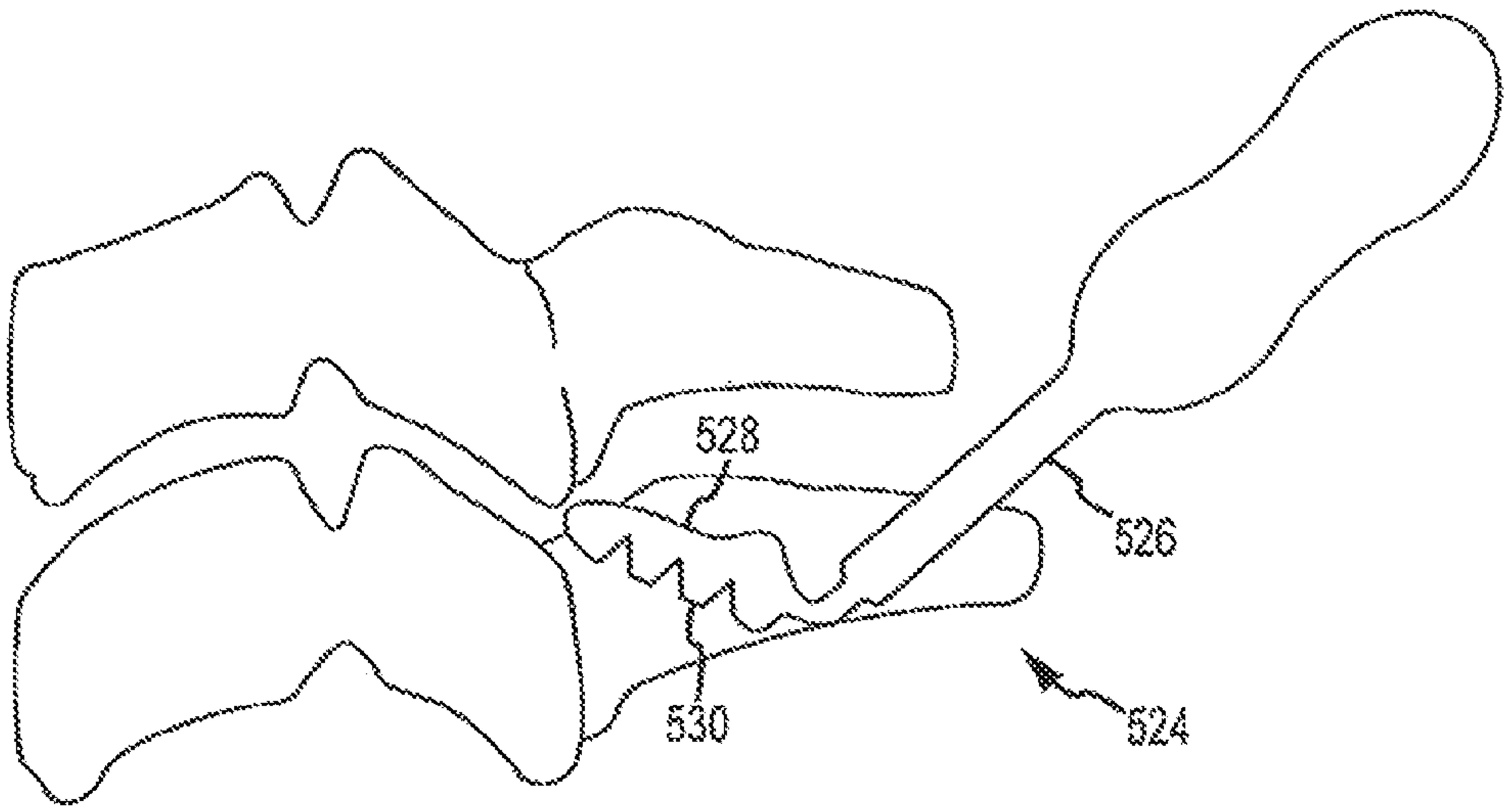


FIG.75A

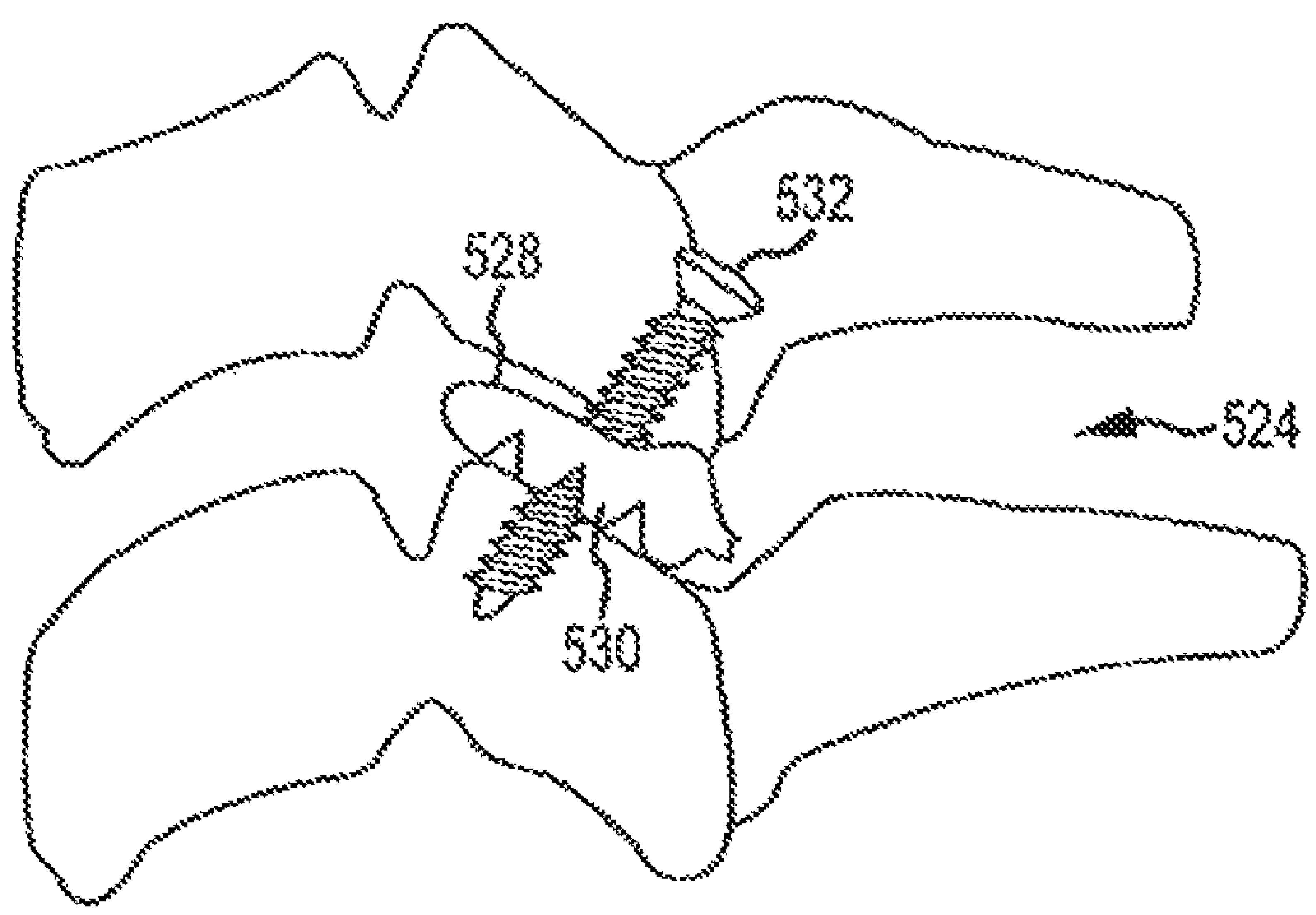


FIG.75B

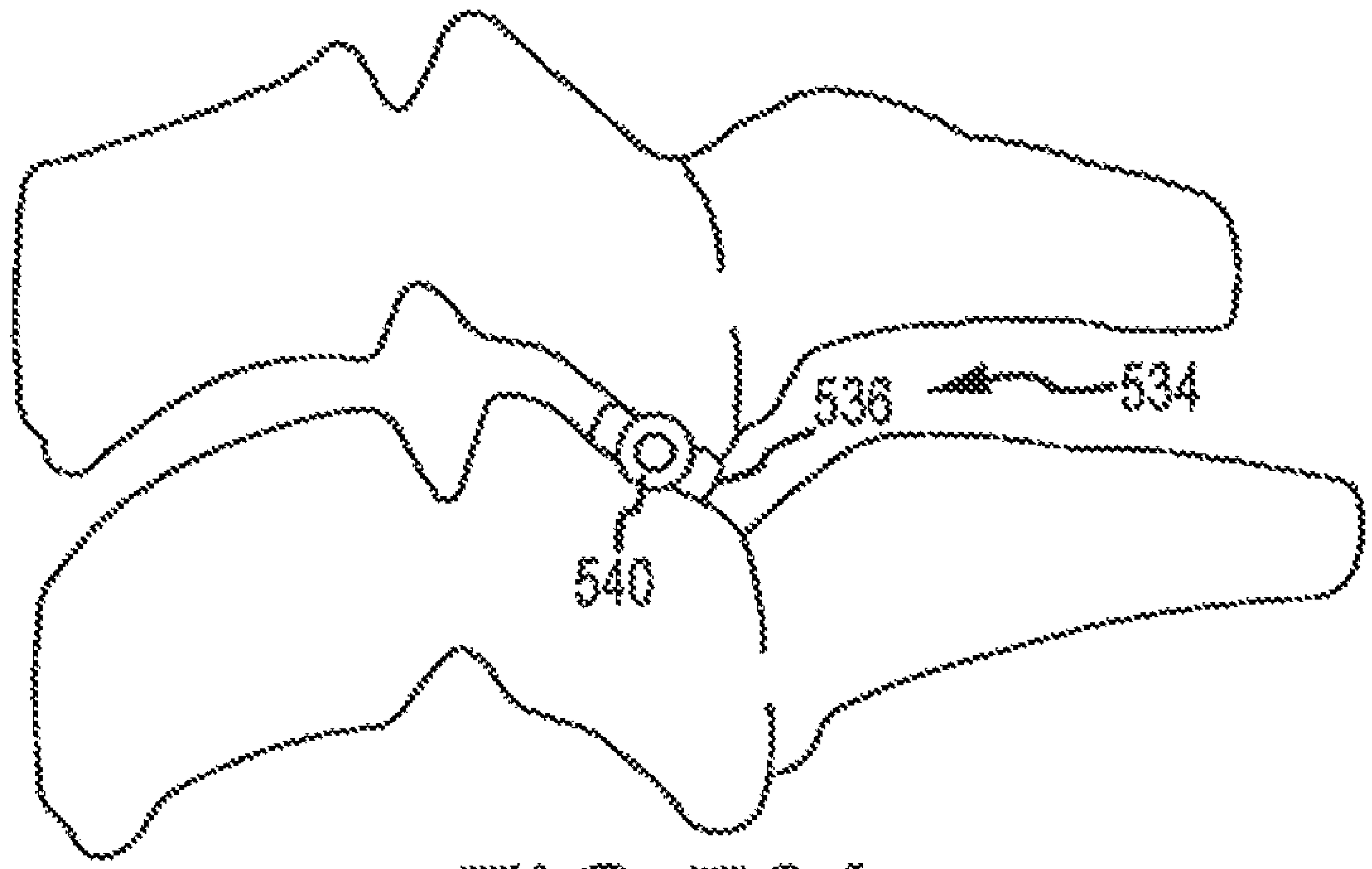


FIG.76A

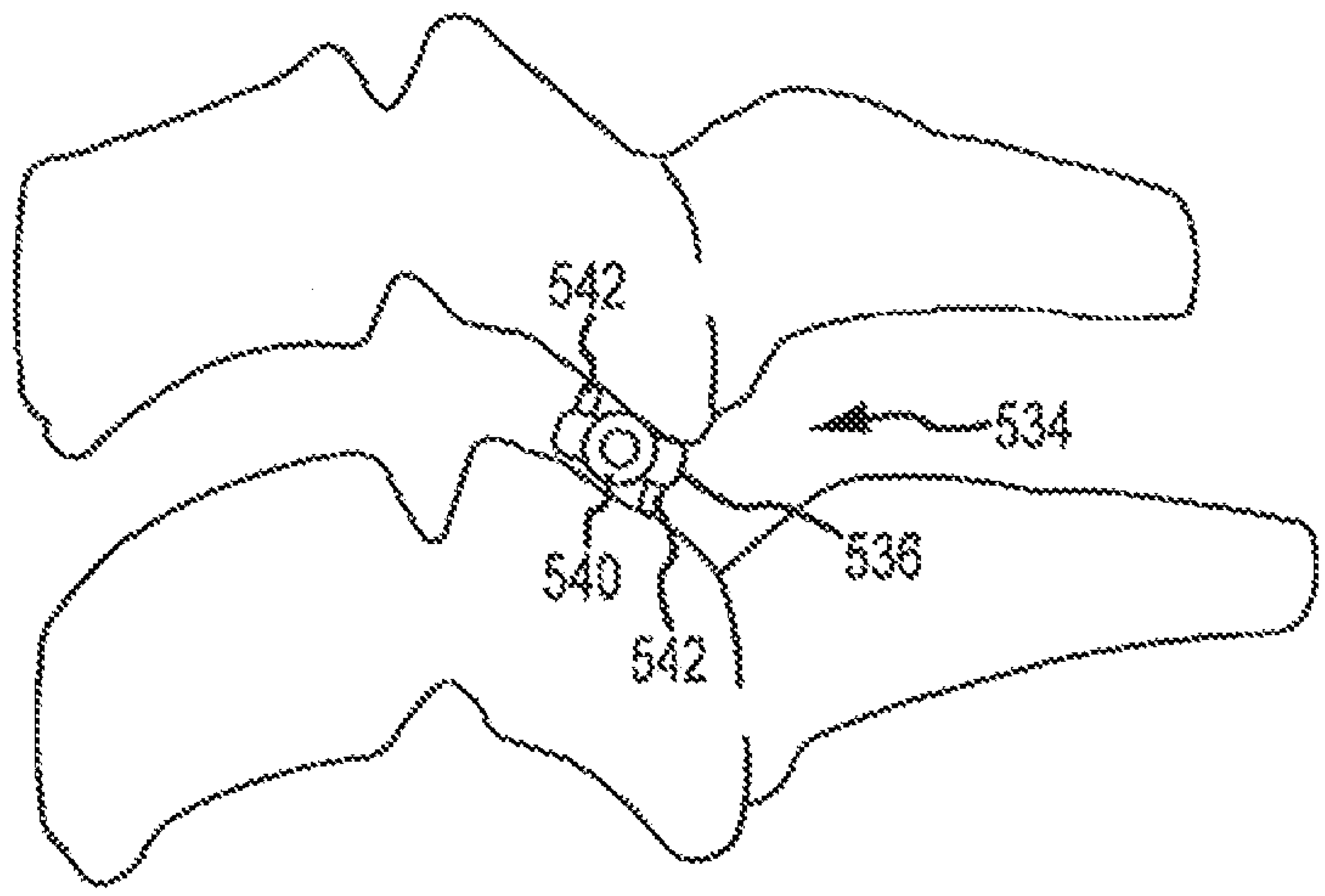


FIG.76B

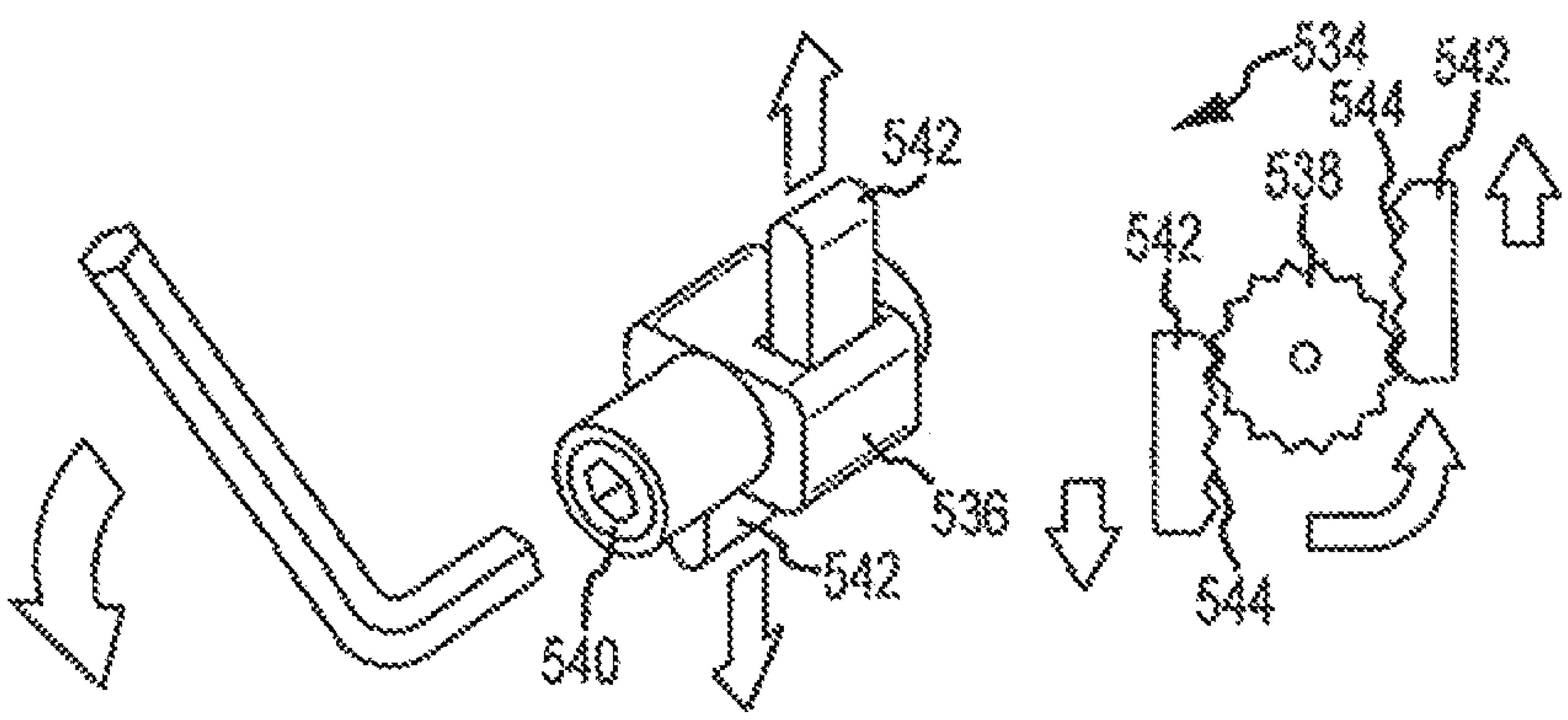


FIG.76C

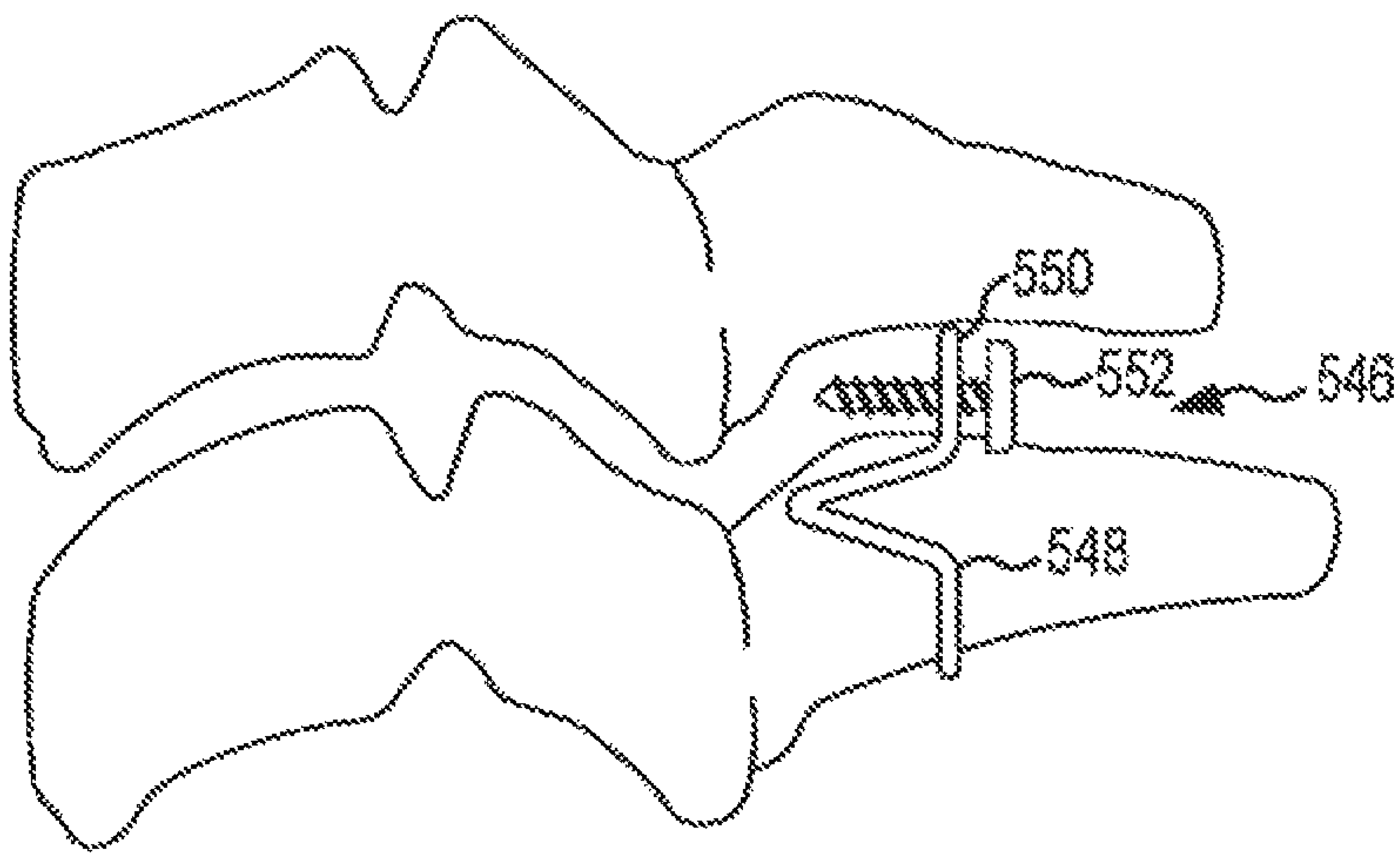


FIG.77A

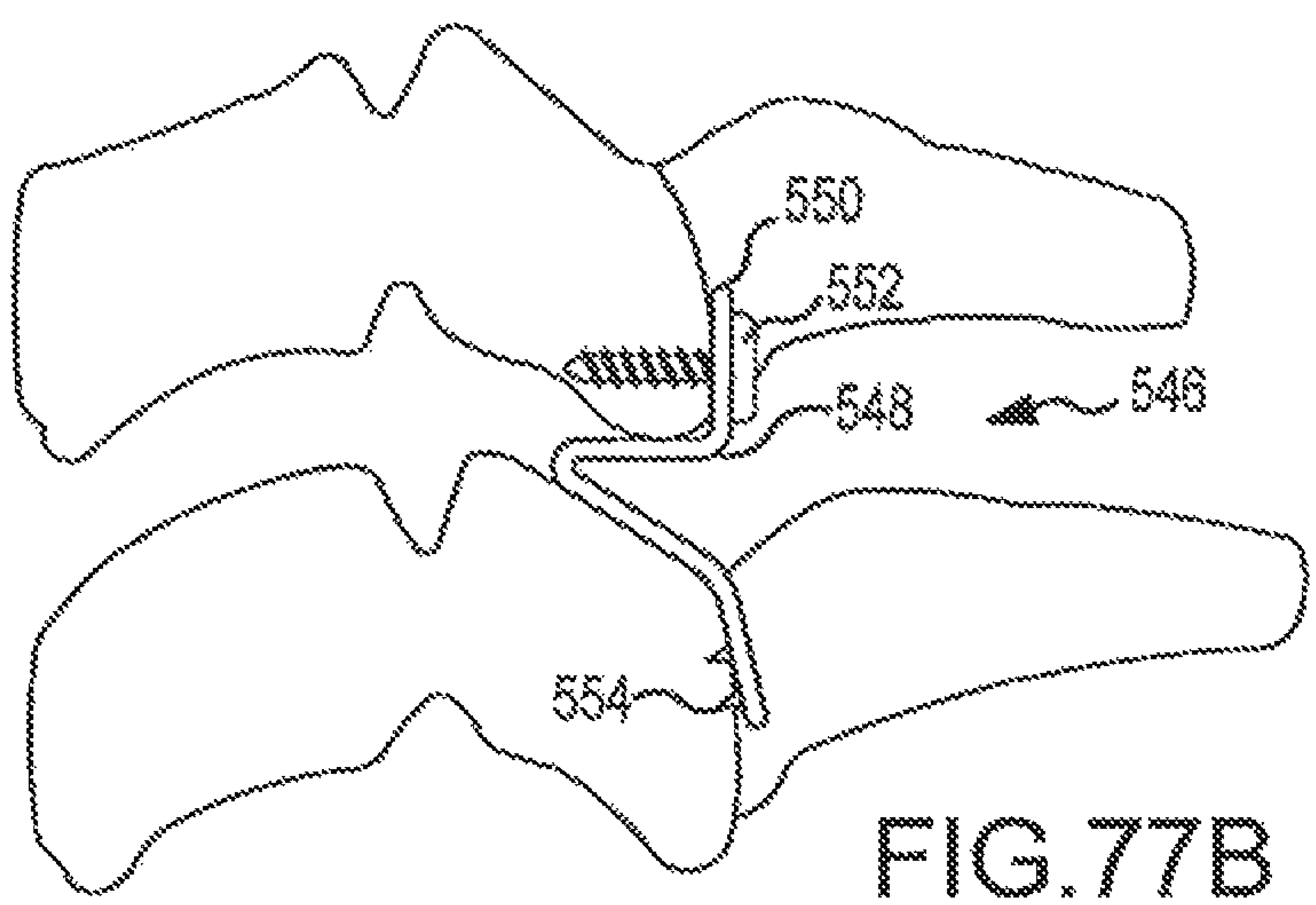


FIG.77B

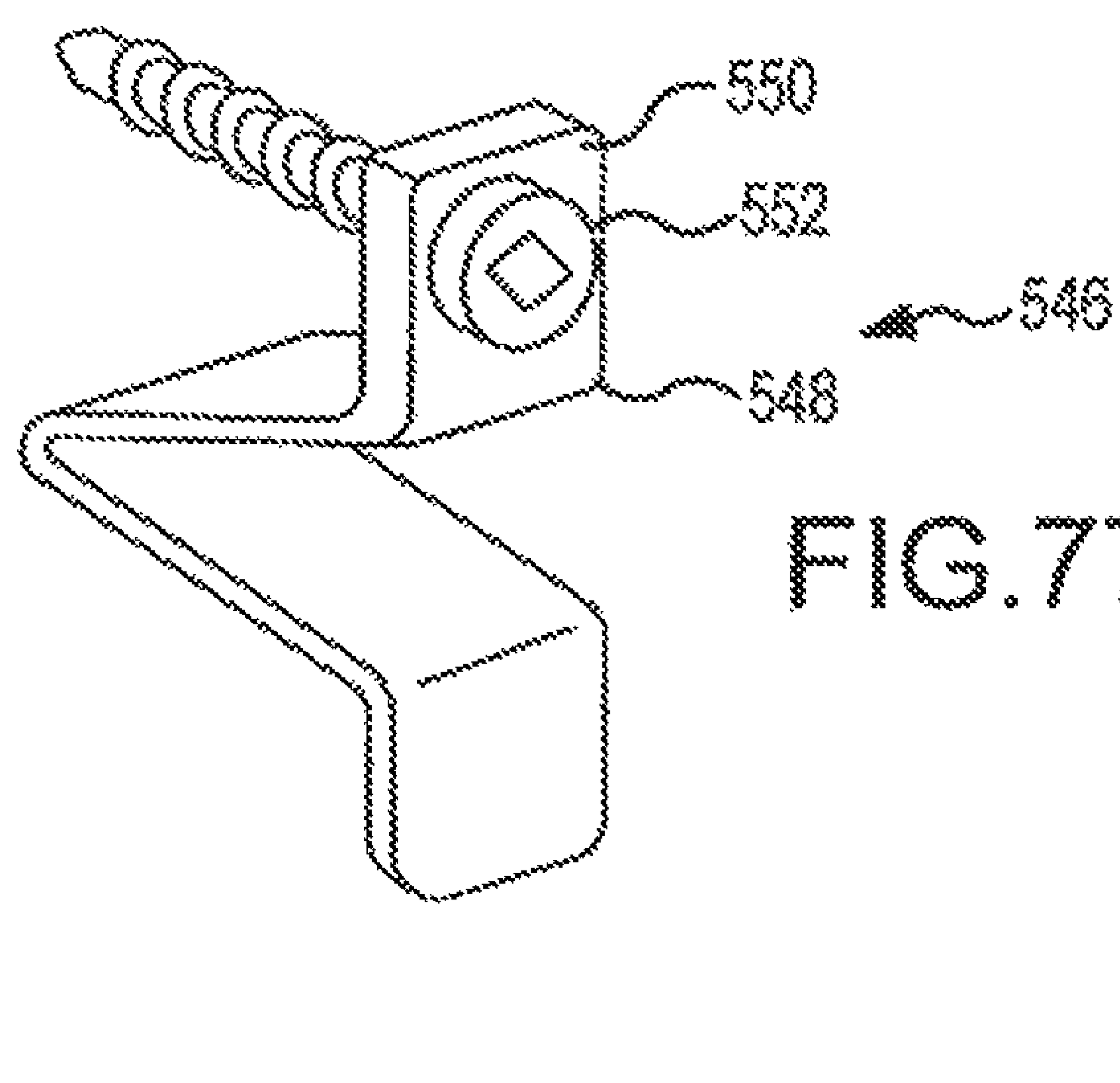


FIG.77C

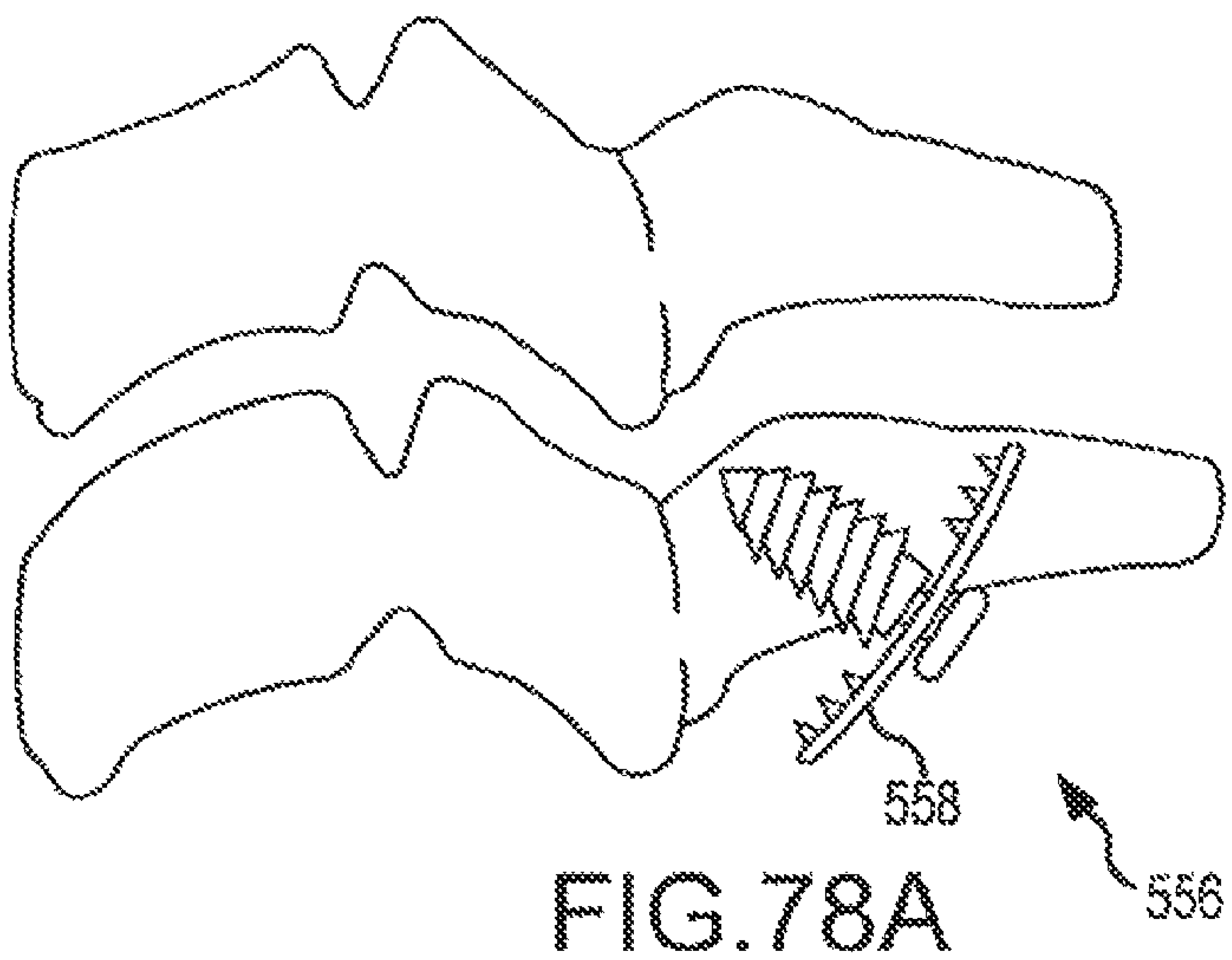


FIG.78A

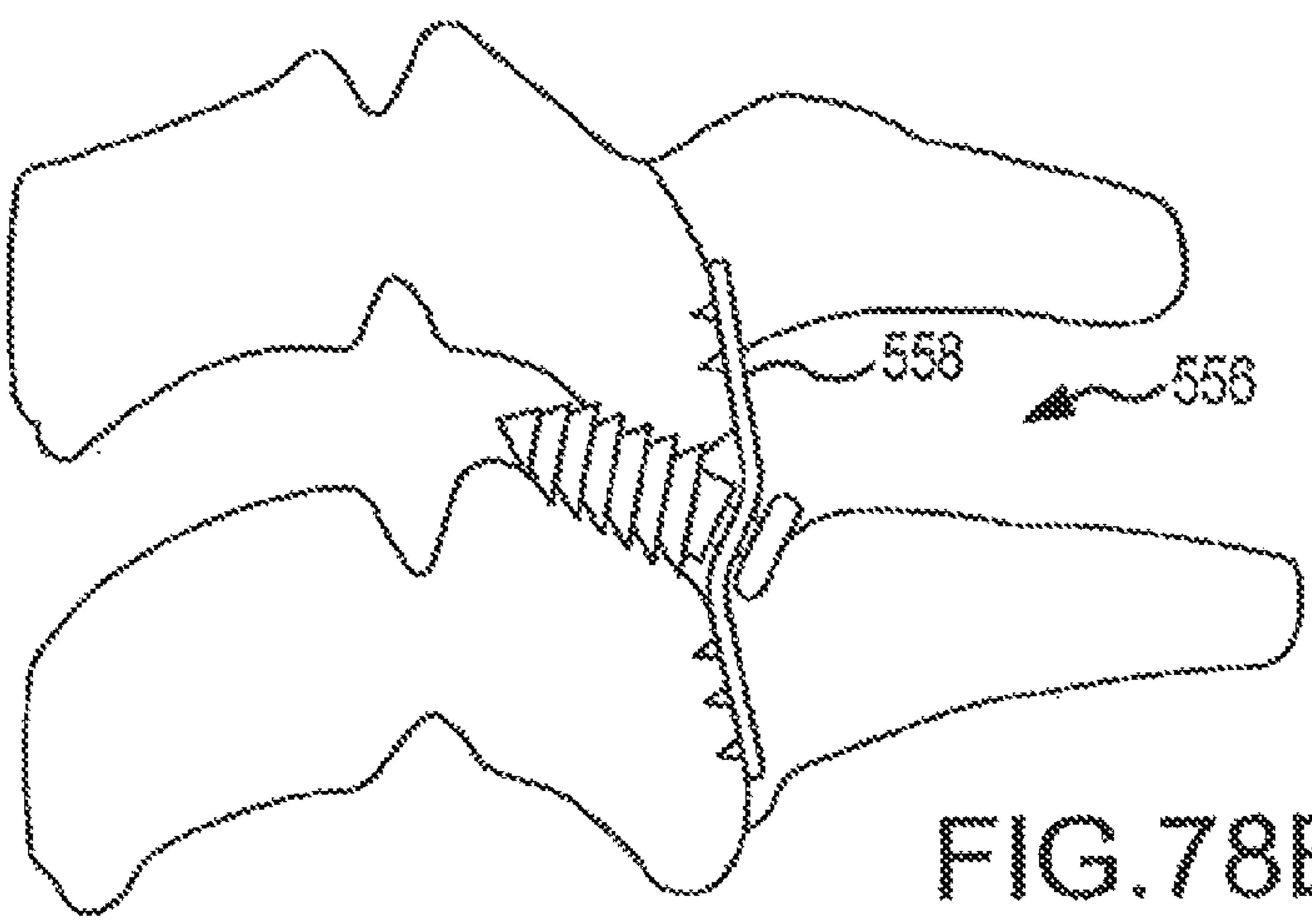


FIG.78B

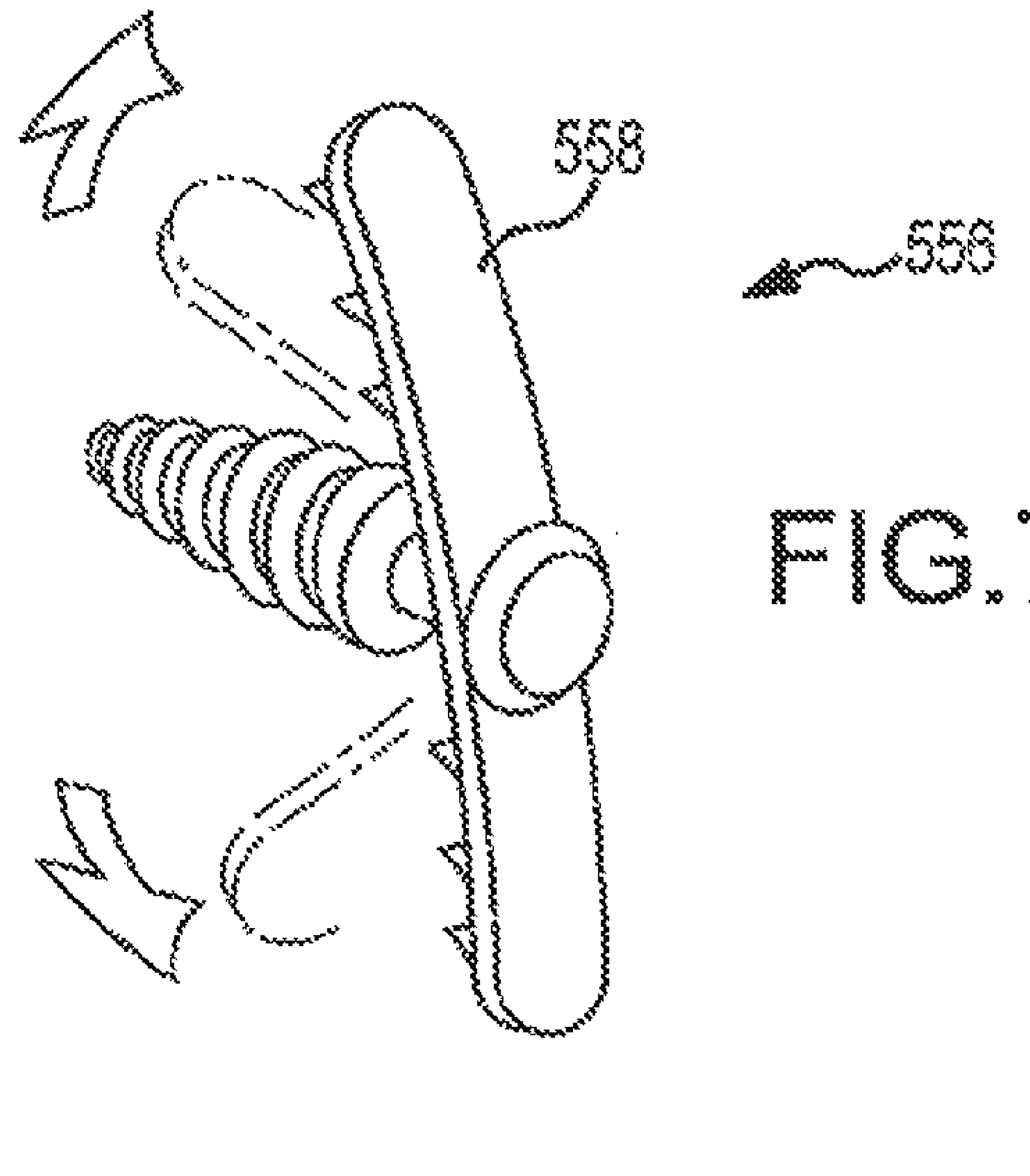


FIG.78C

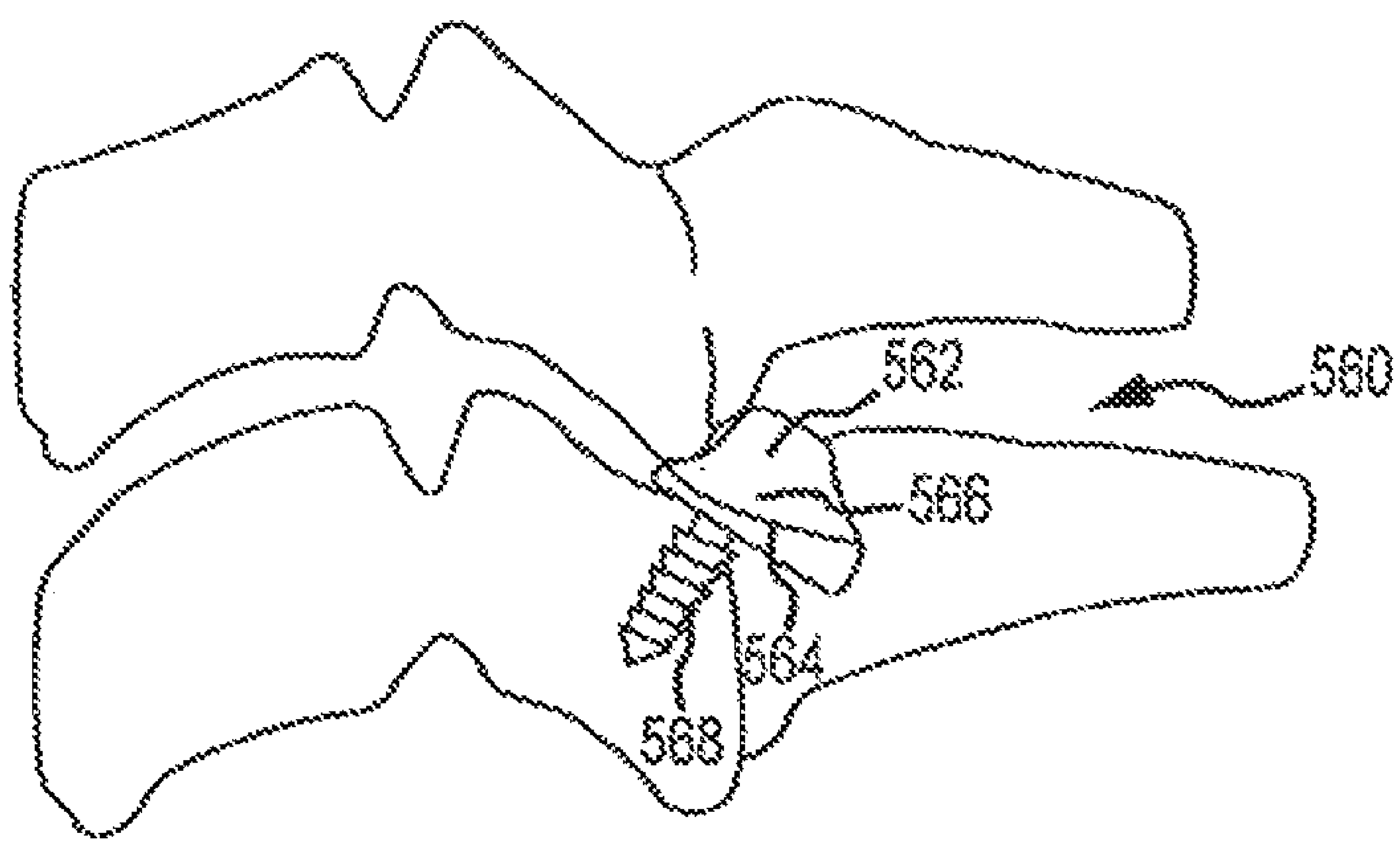


FIG.79A

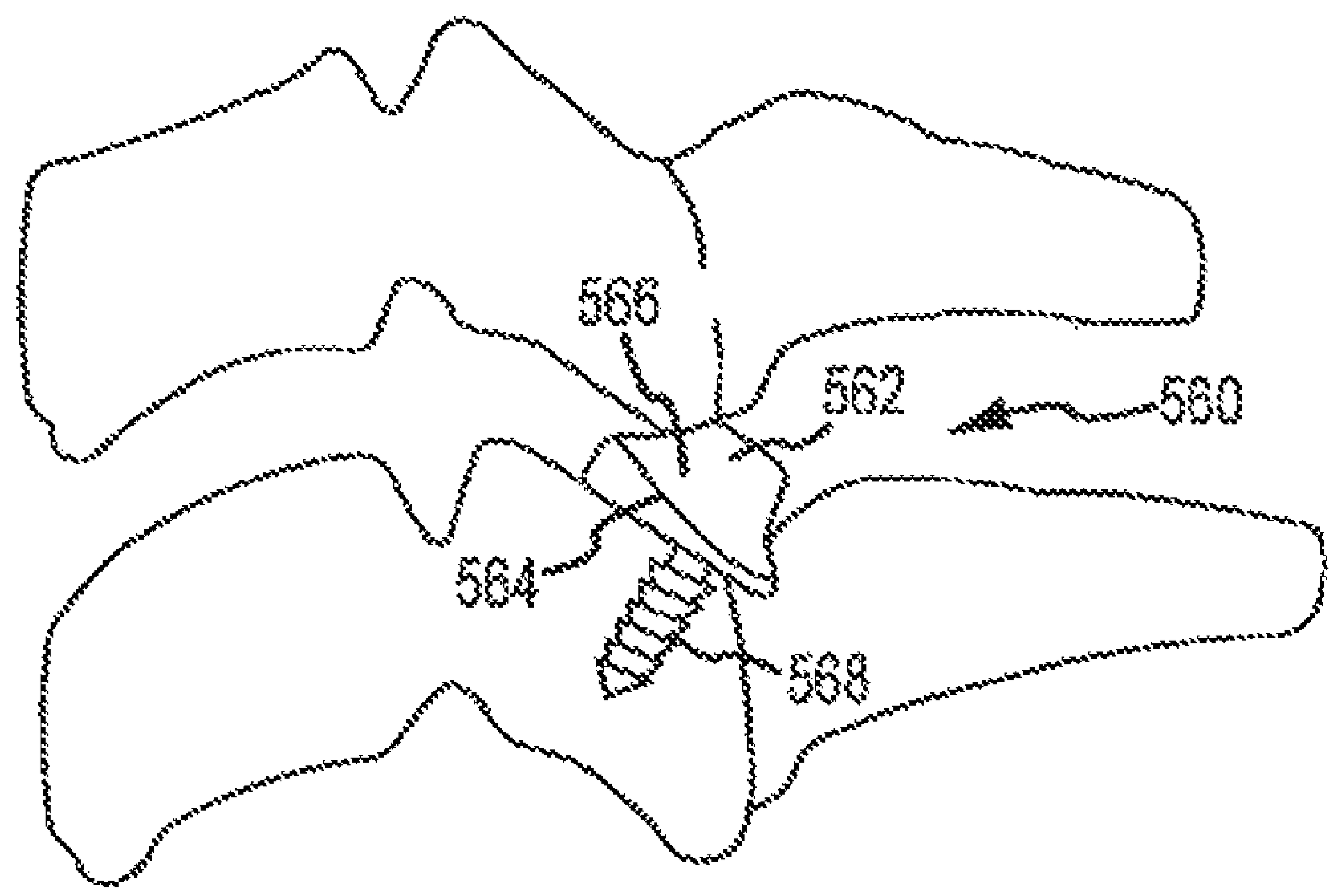


FIG.79B

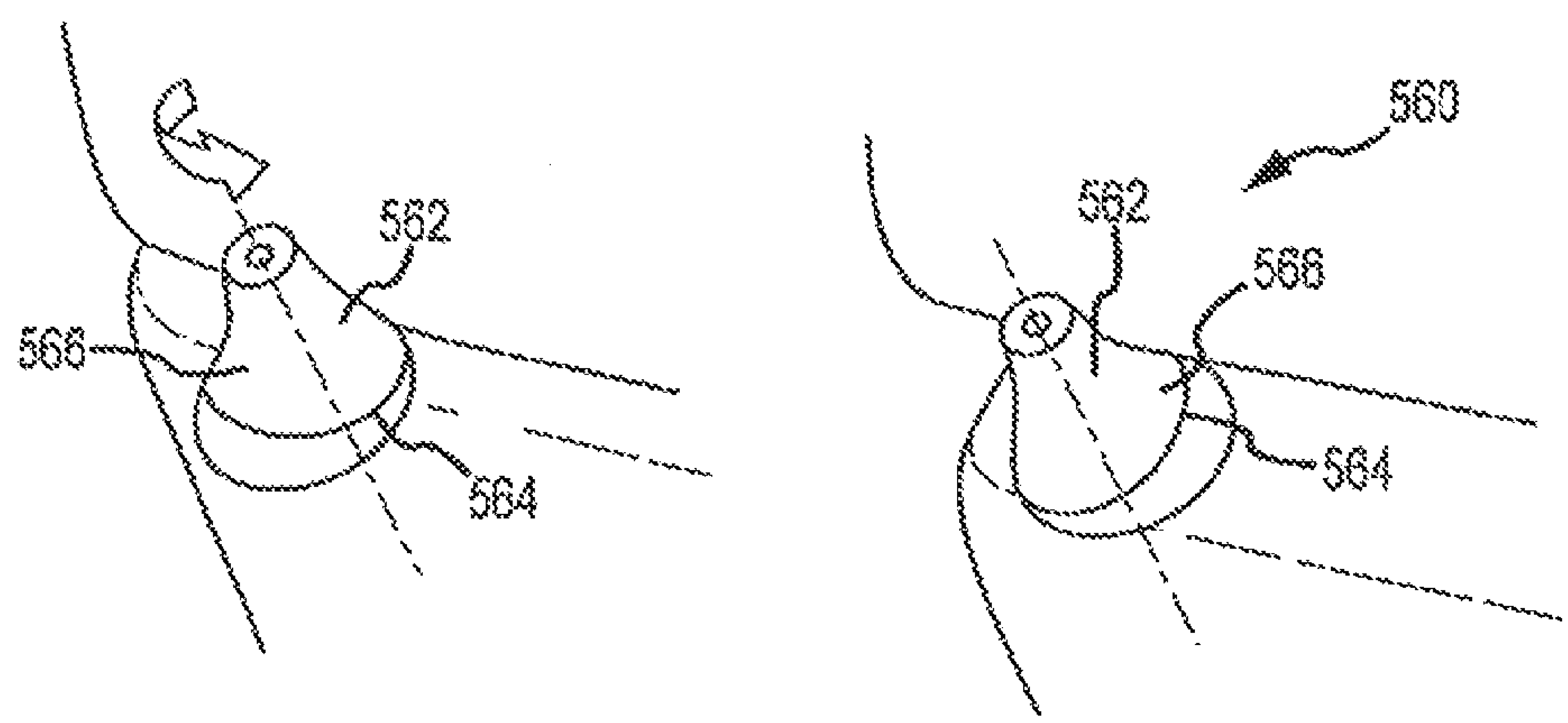


FIG.79C

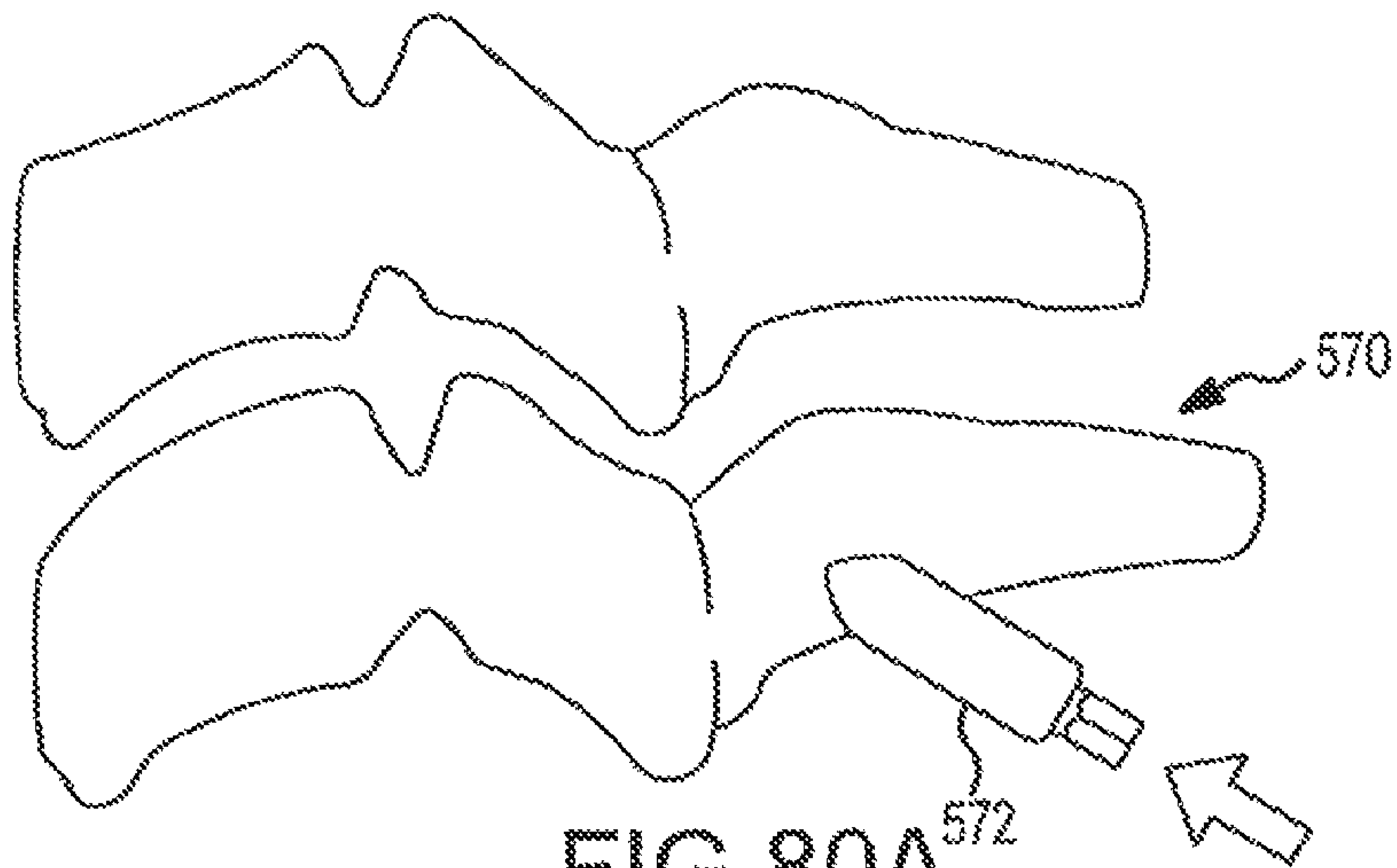


FIG.80A

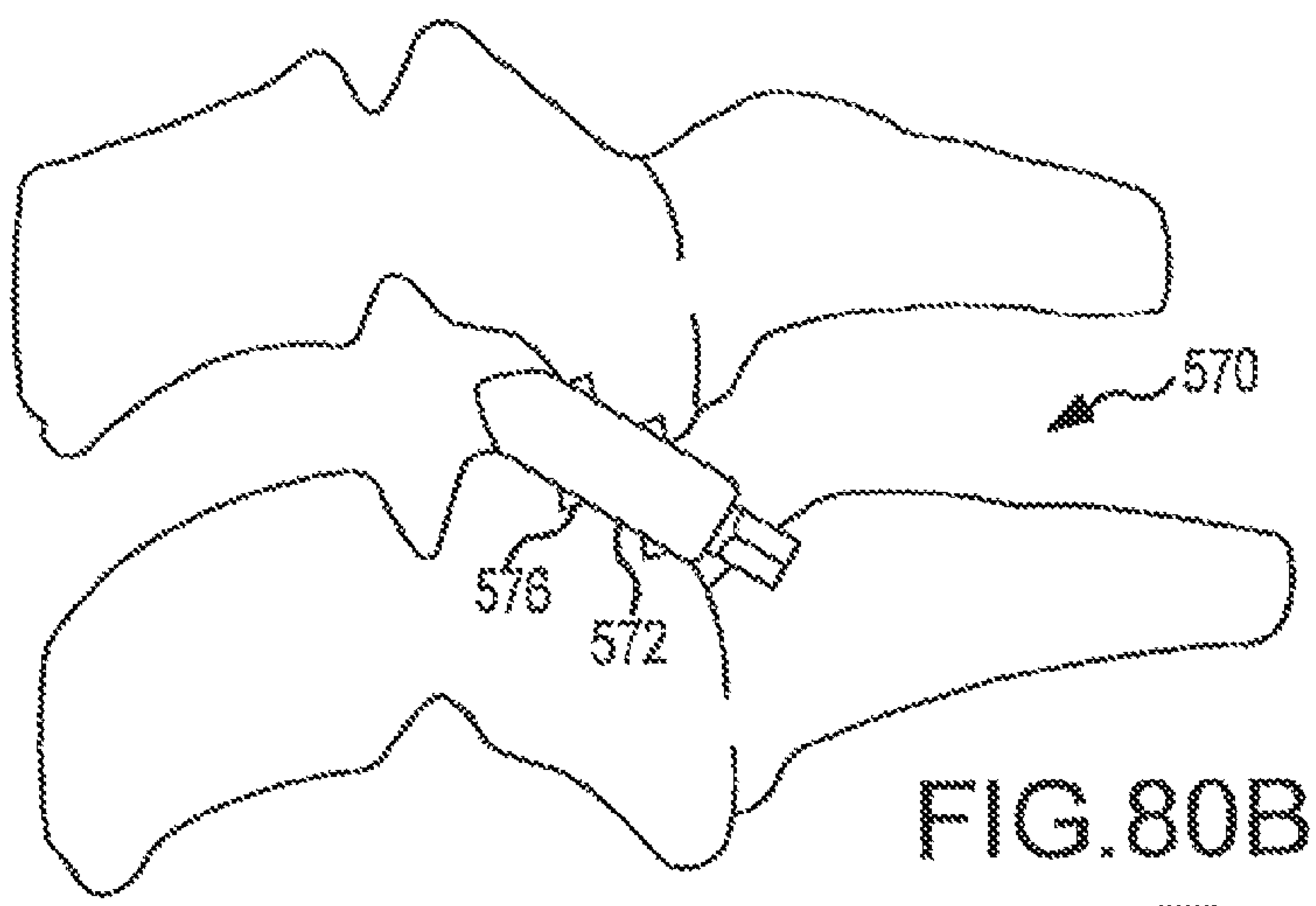


FIG.80B

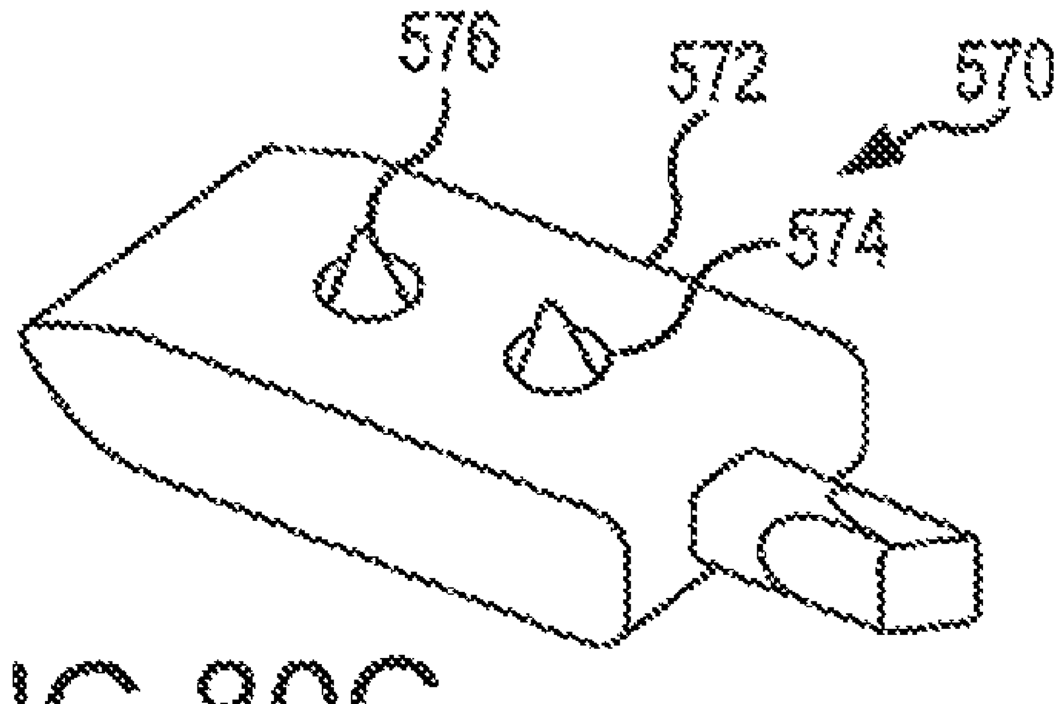


FIG.80C

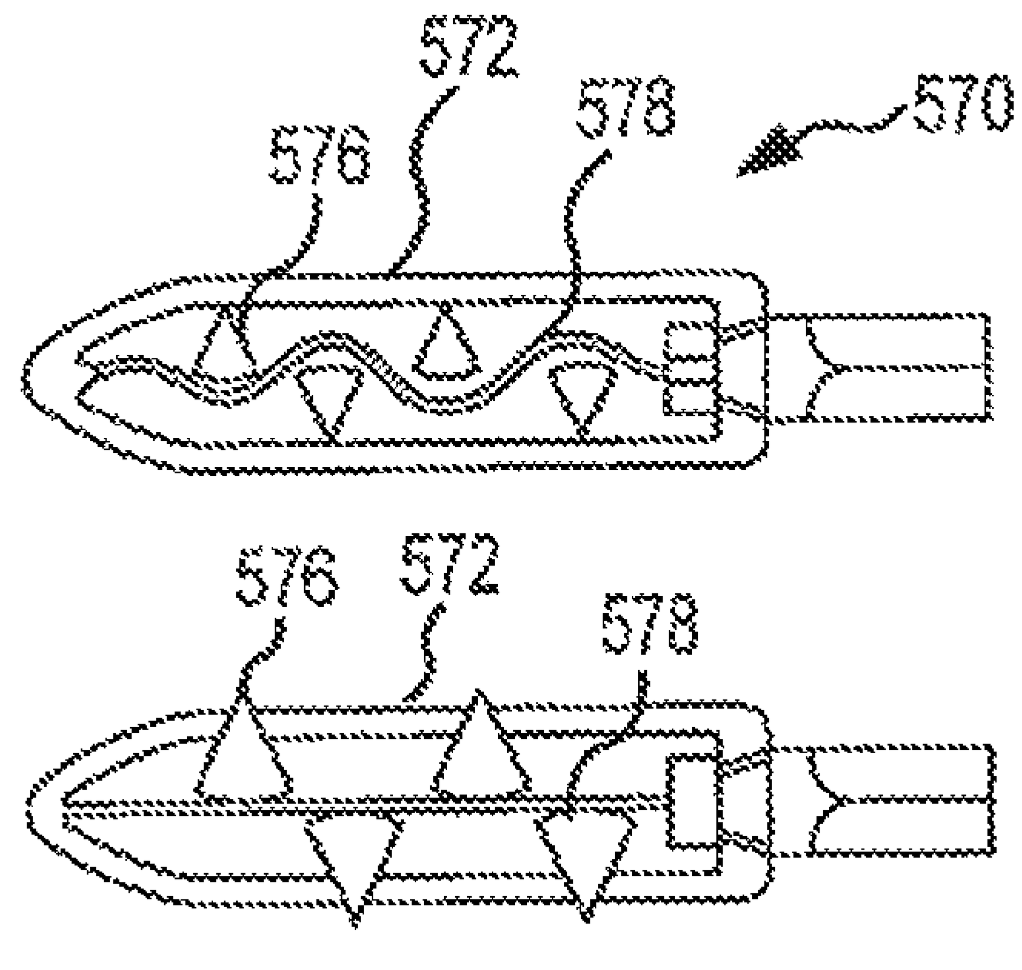


FIG.80D

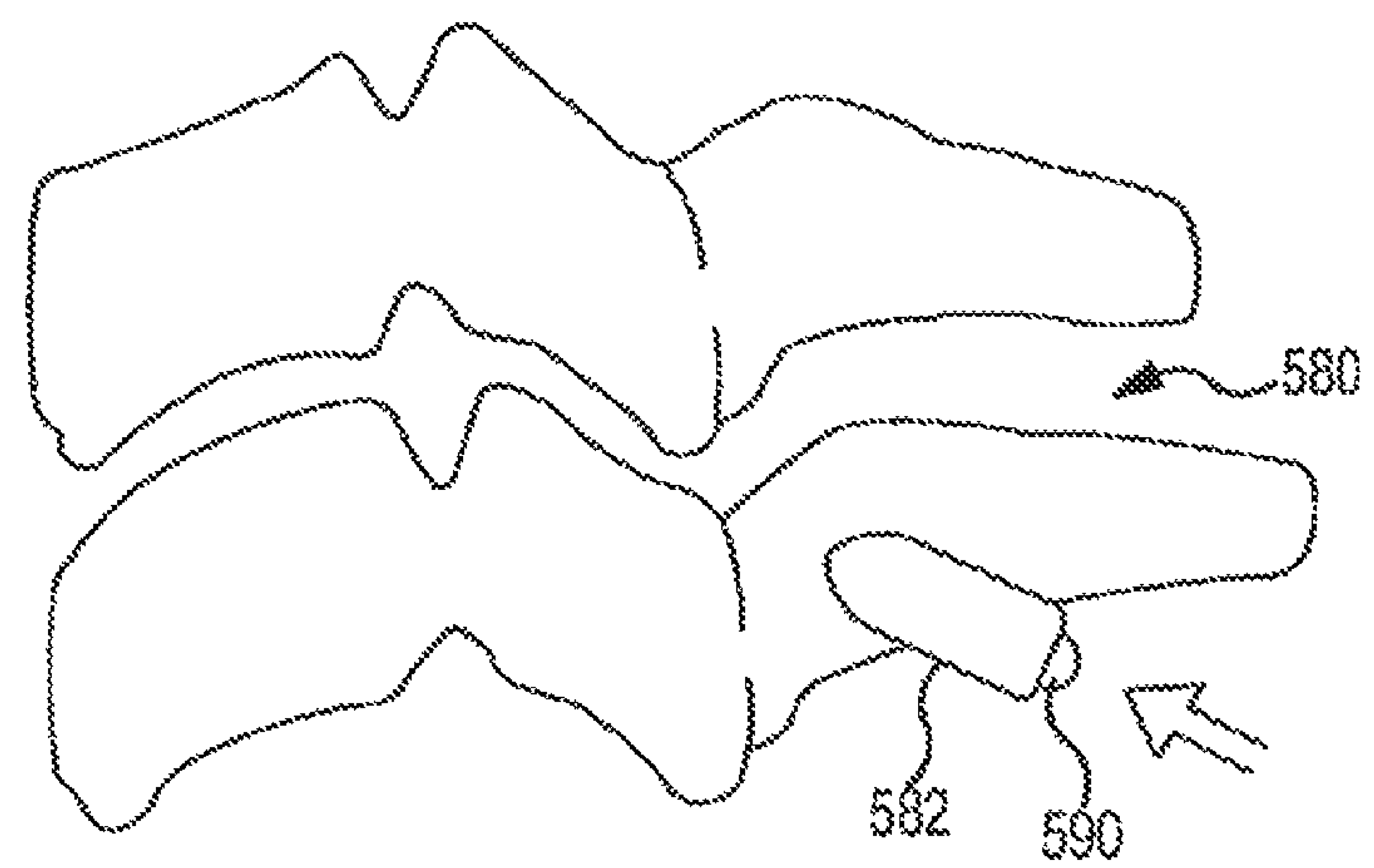


FIG.81A

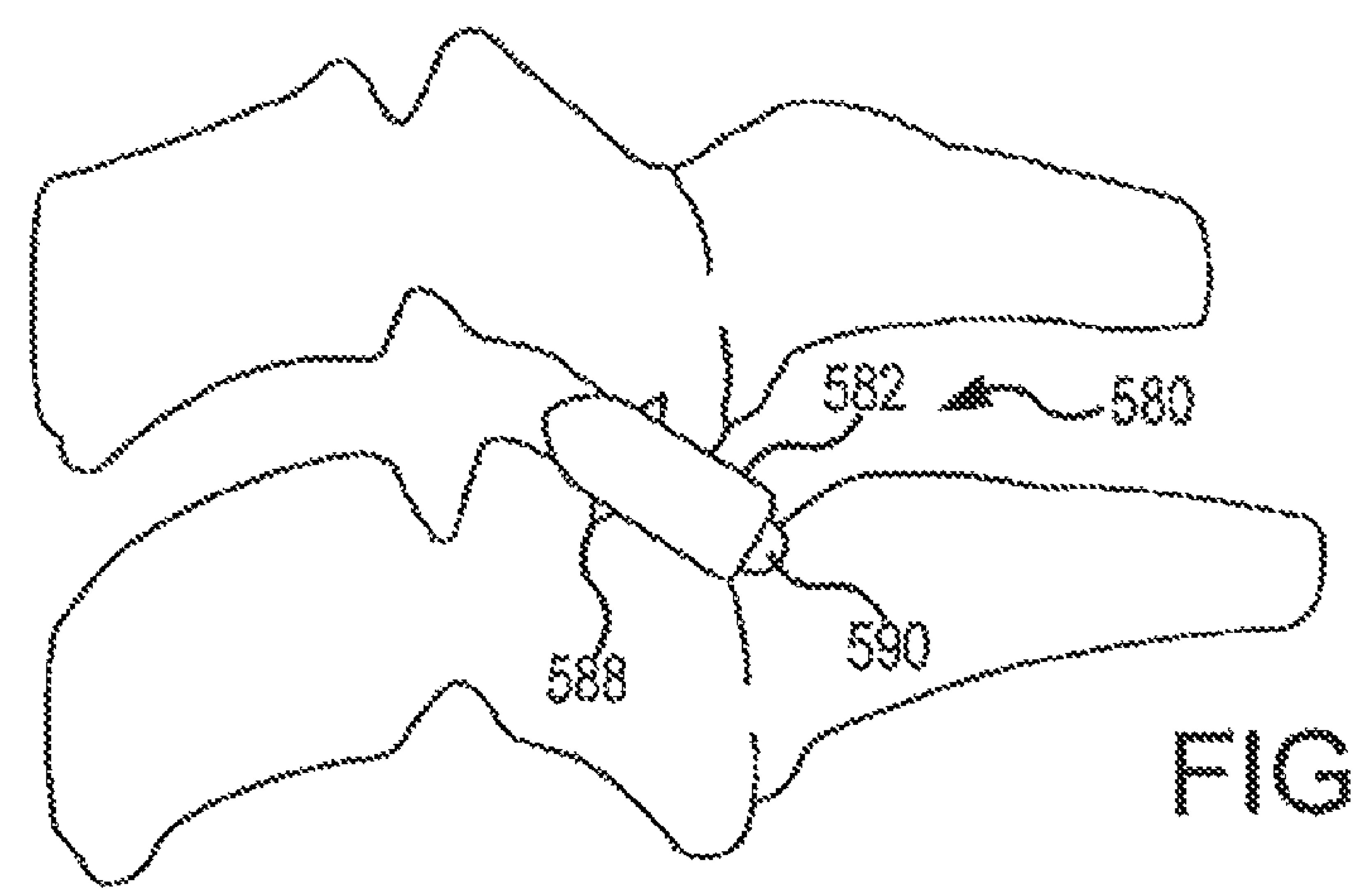


FIG.81B

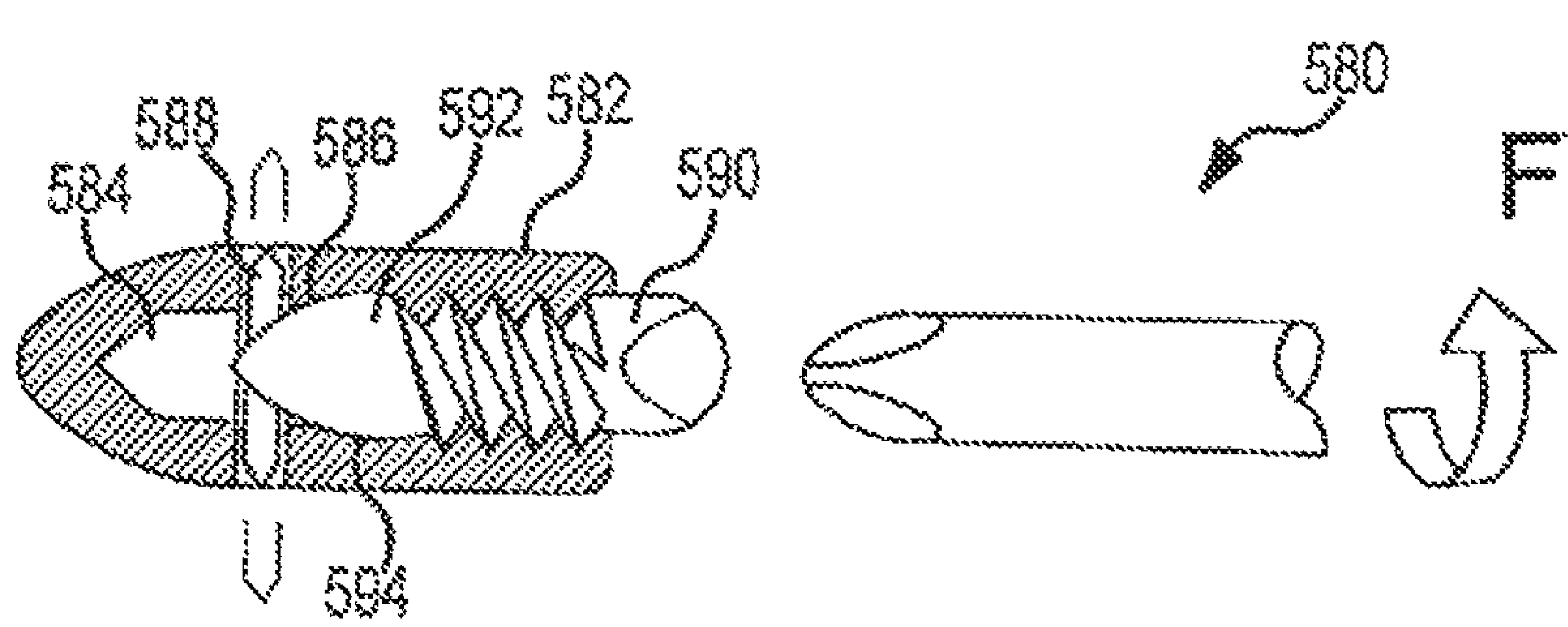


FIG.81C

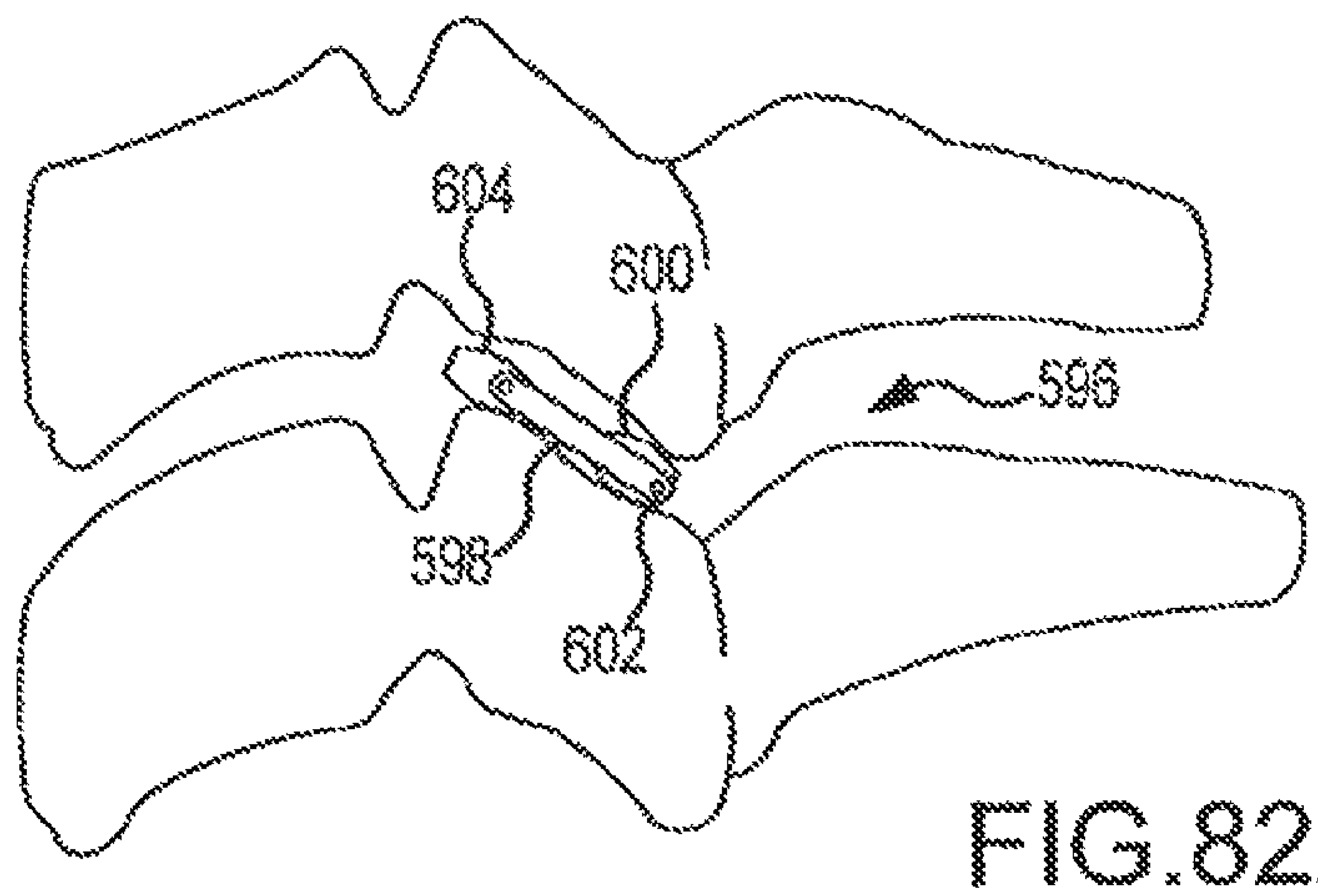


FIG.82A

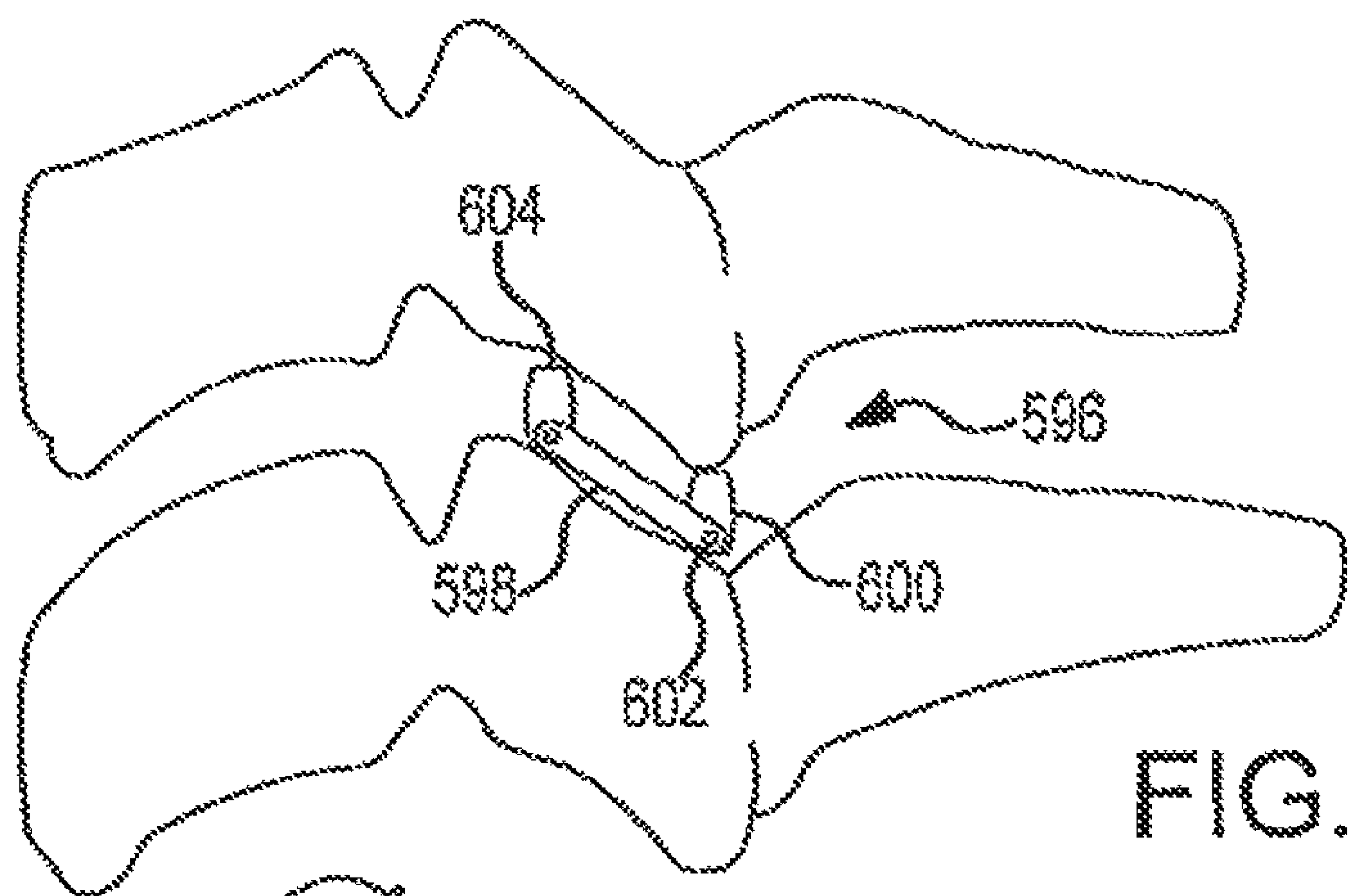


FIG.82B

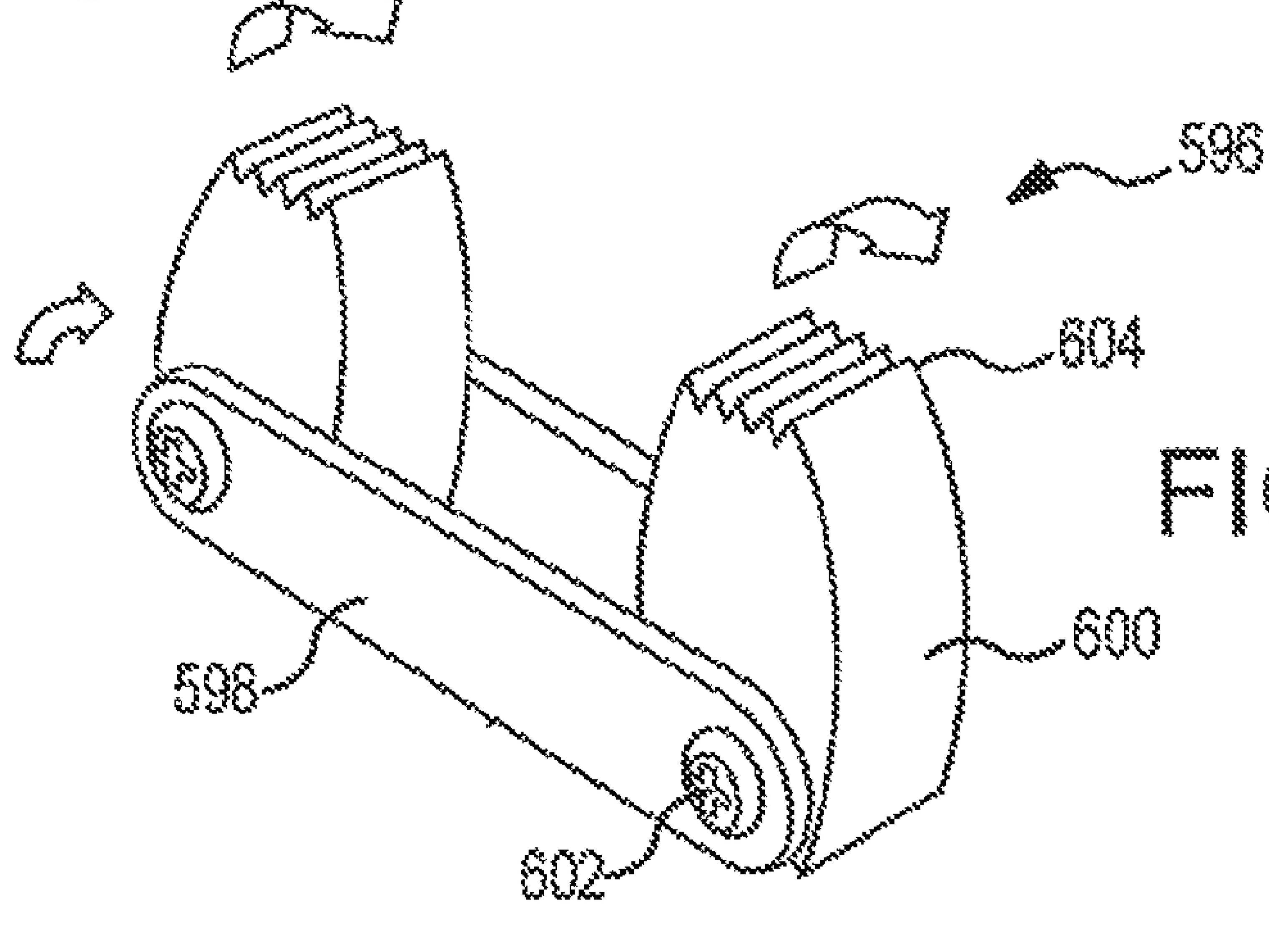


FIG.82C

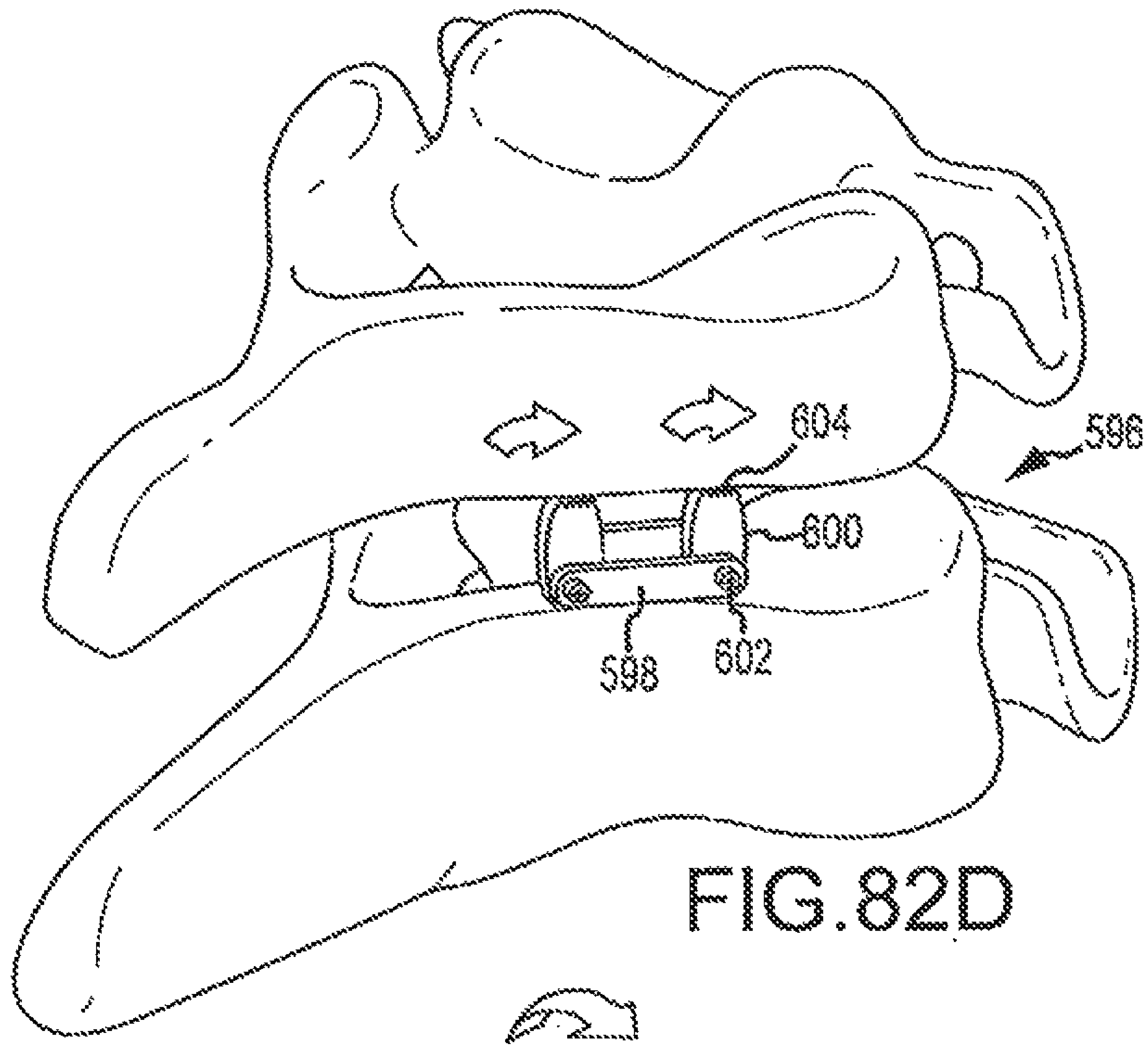


FIG.82D

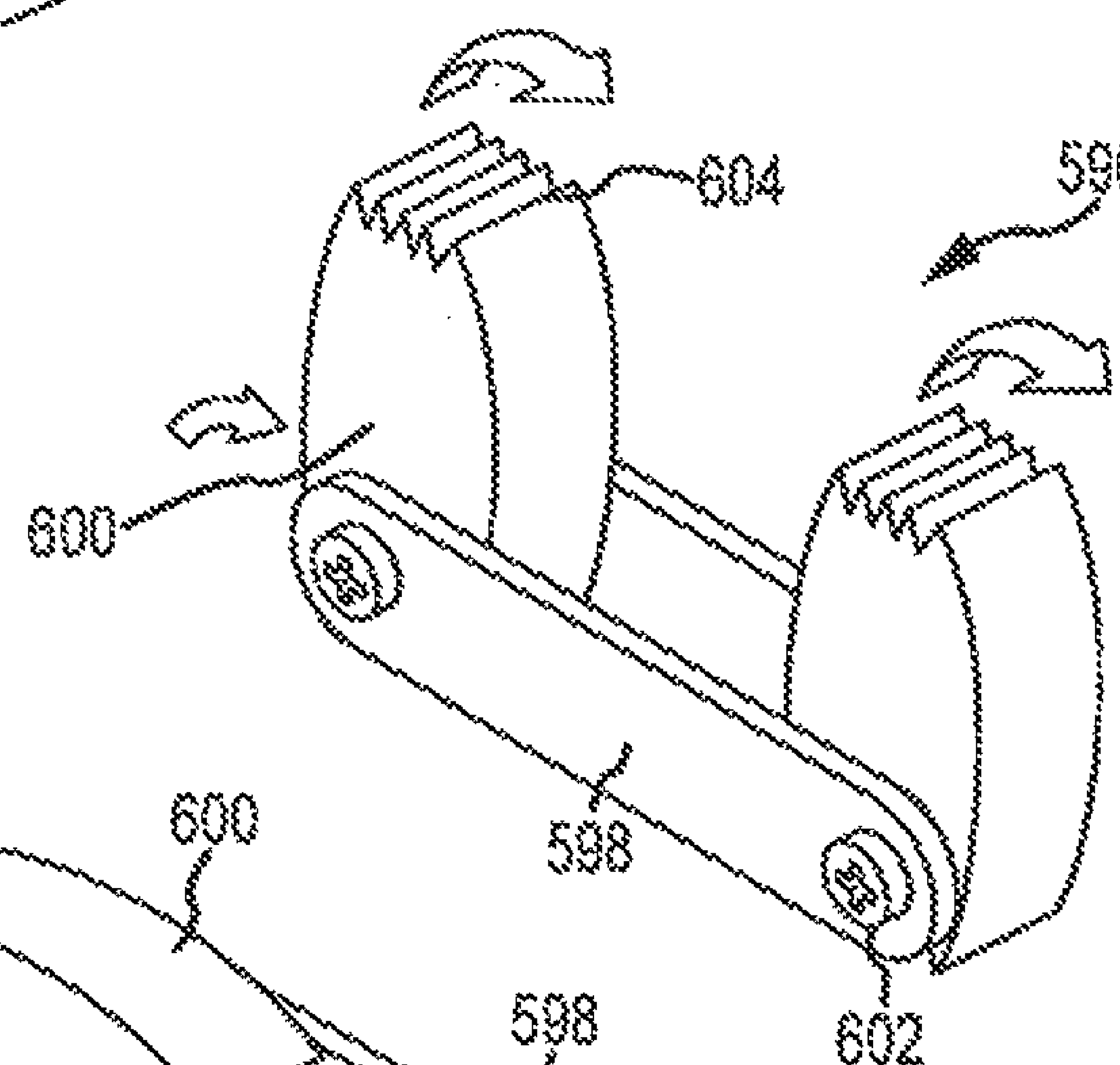


FIG.82E

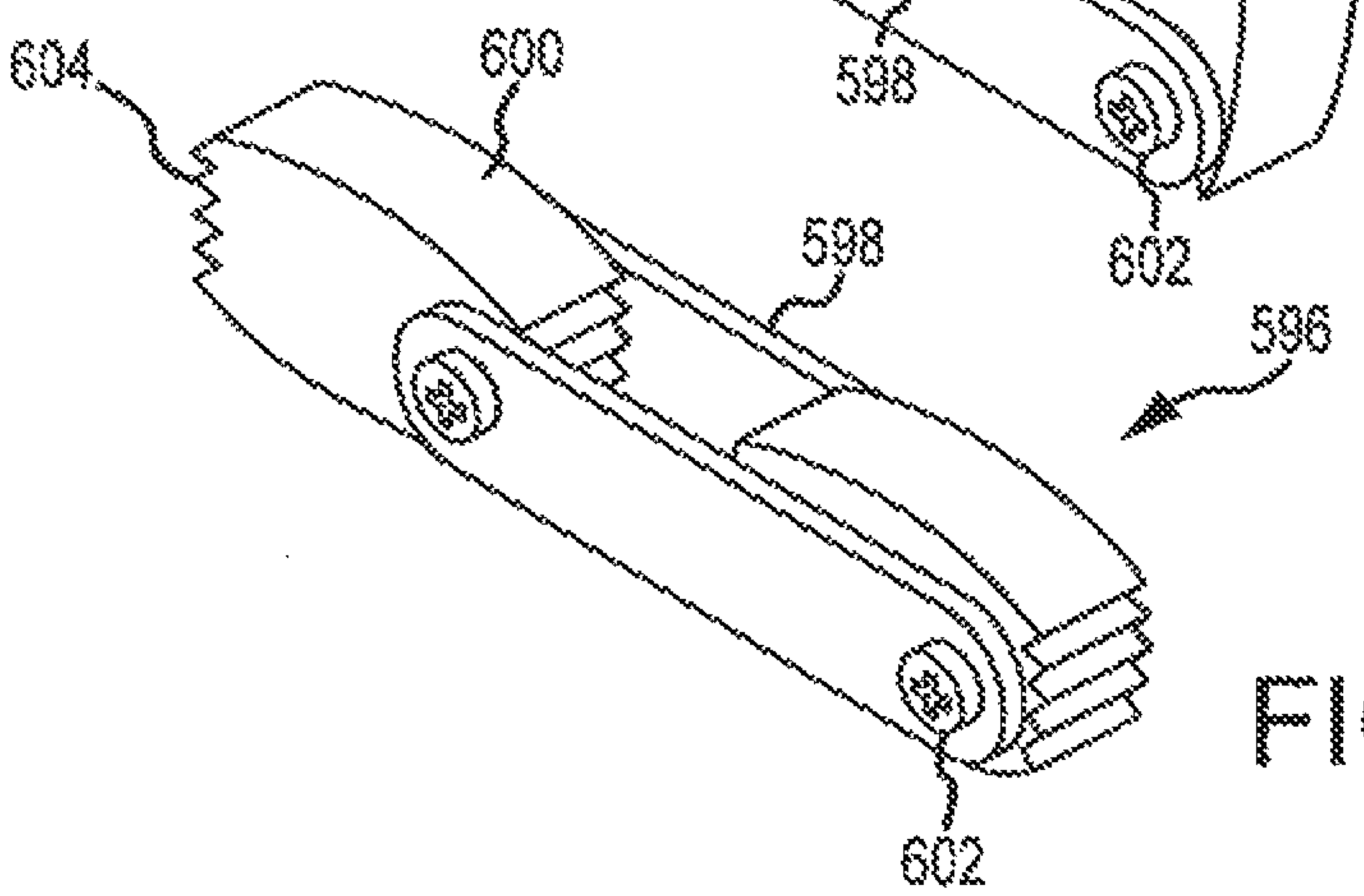


FIG.82F

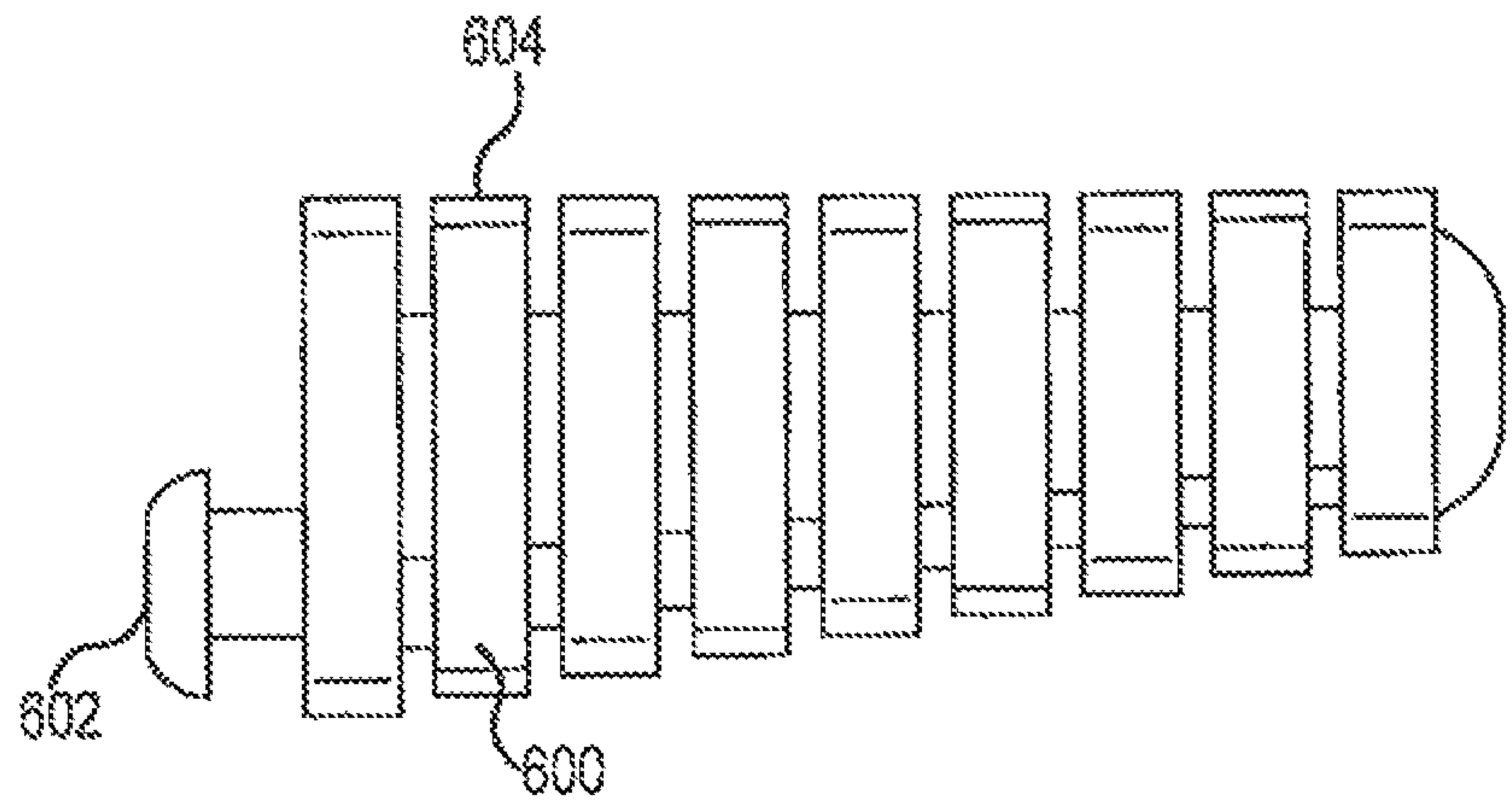


FIG. 83A

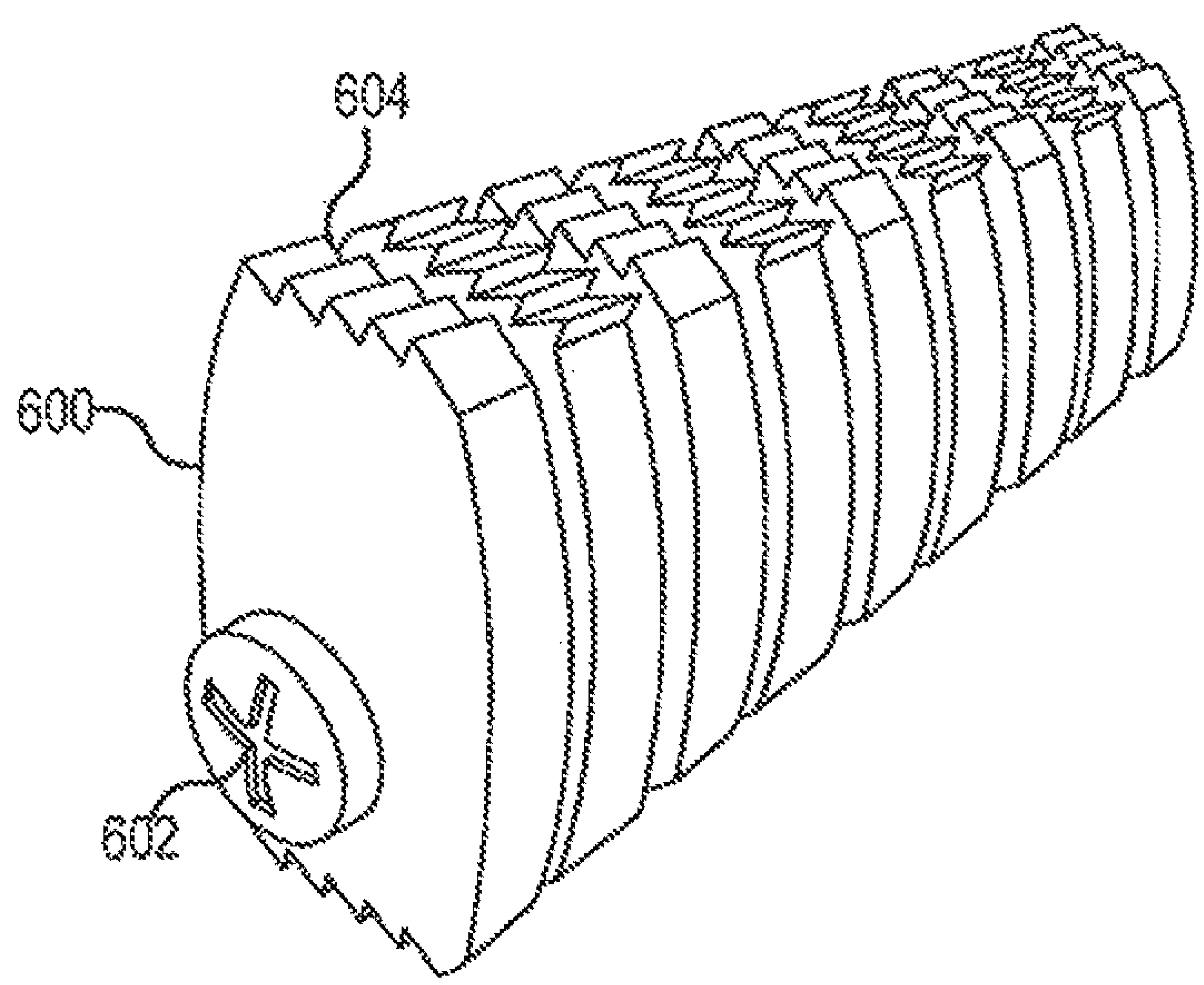


FIG. 83B

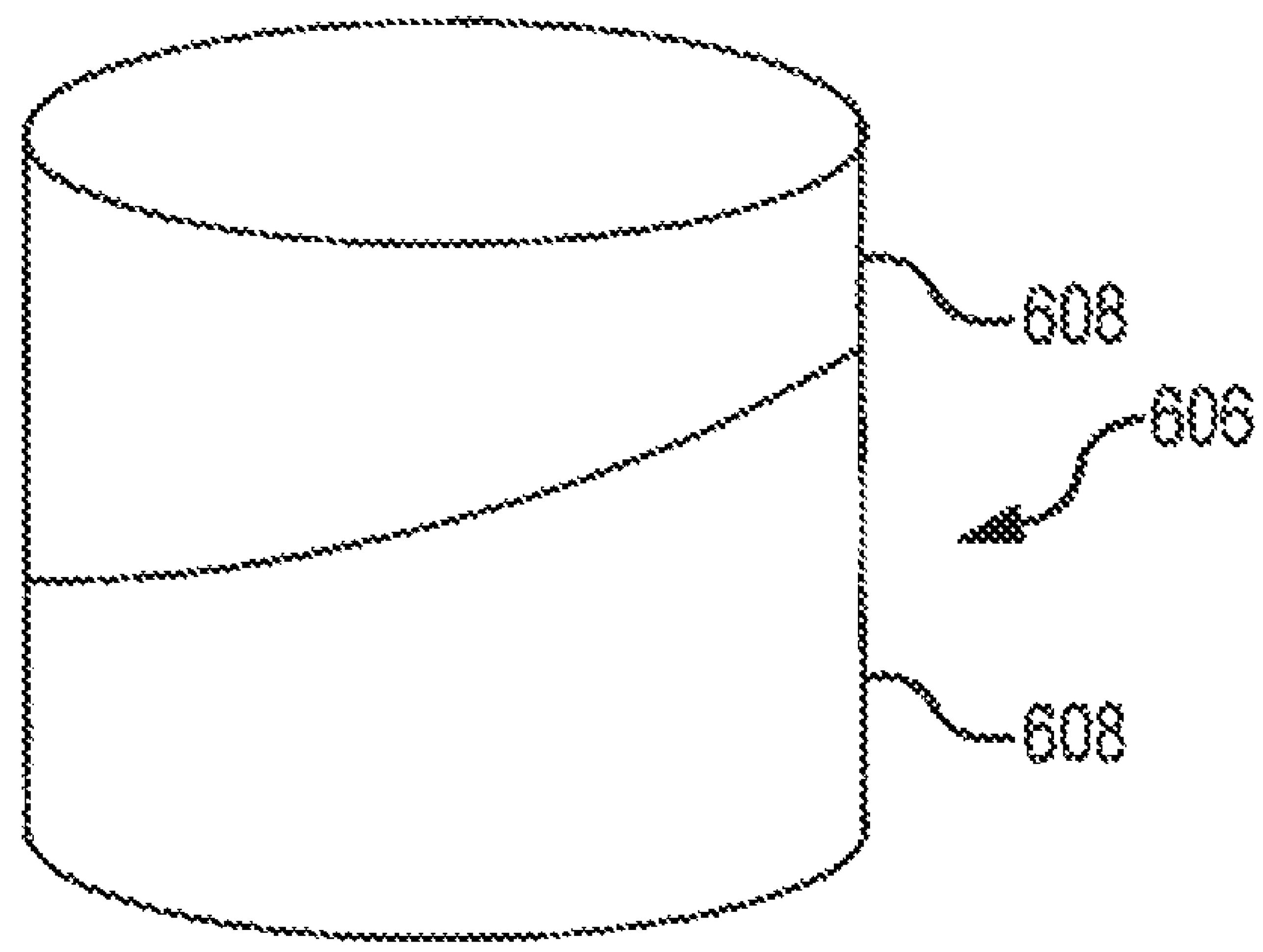


FIG.84A

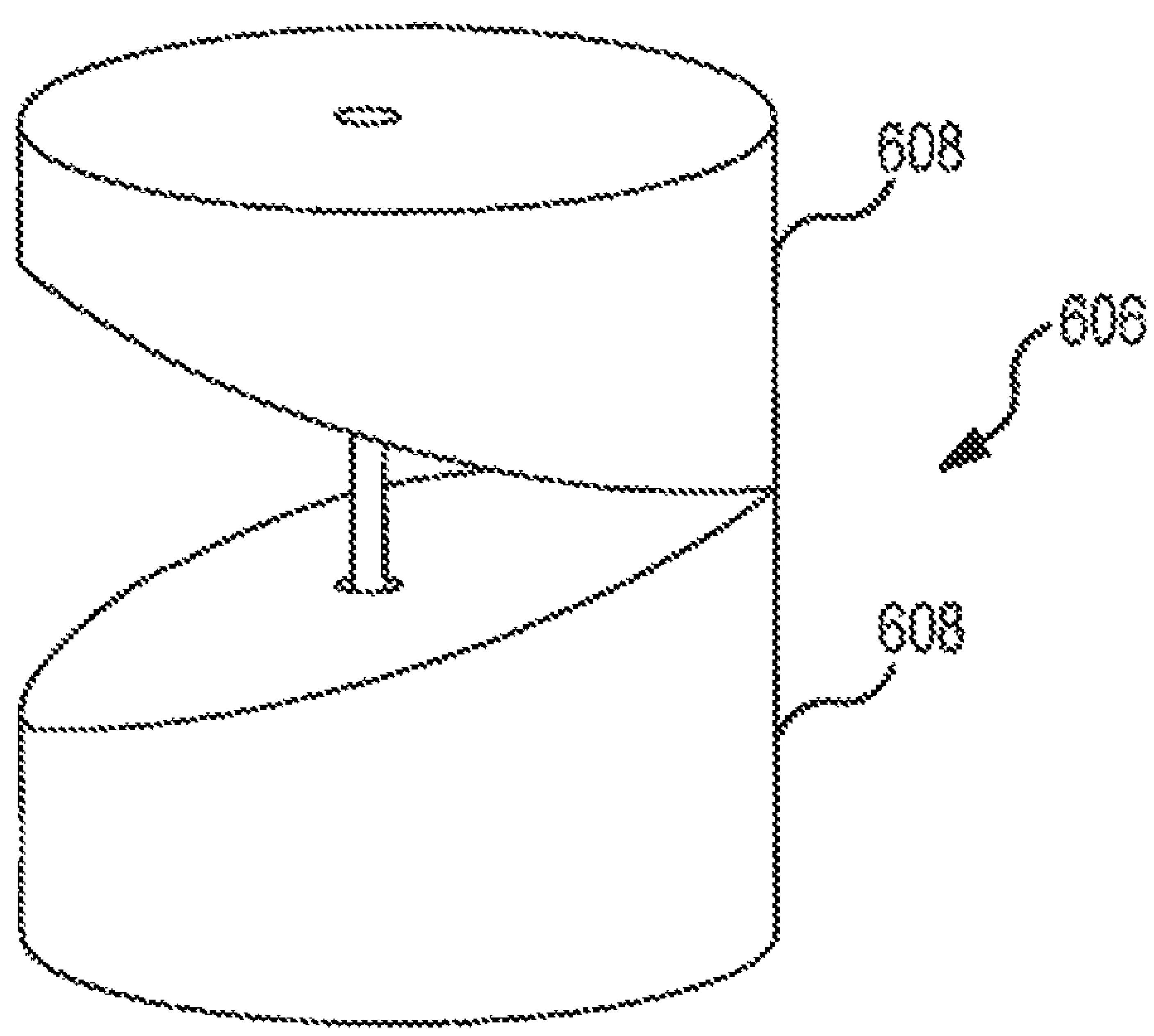


FIG.84B

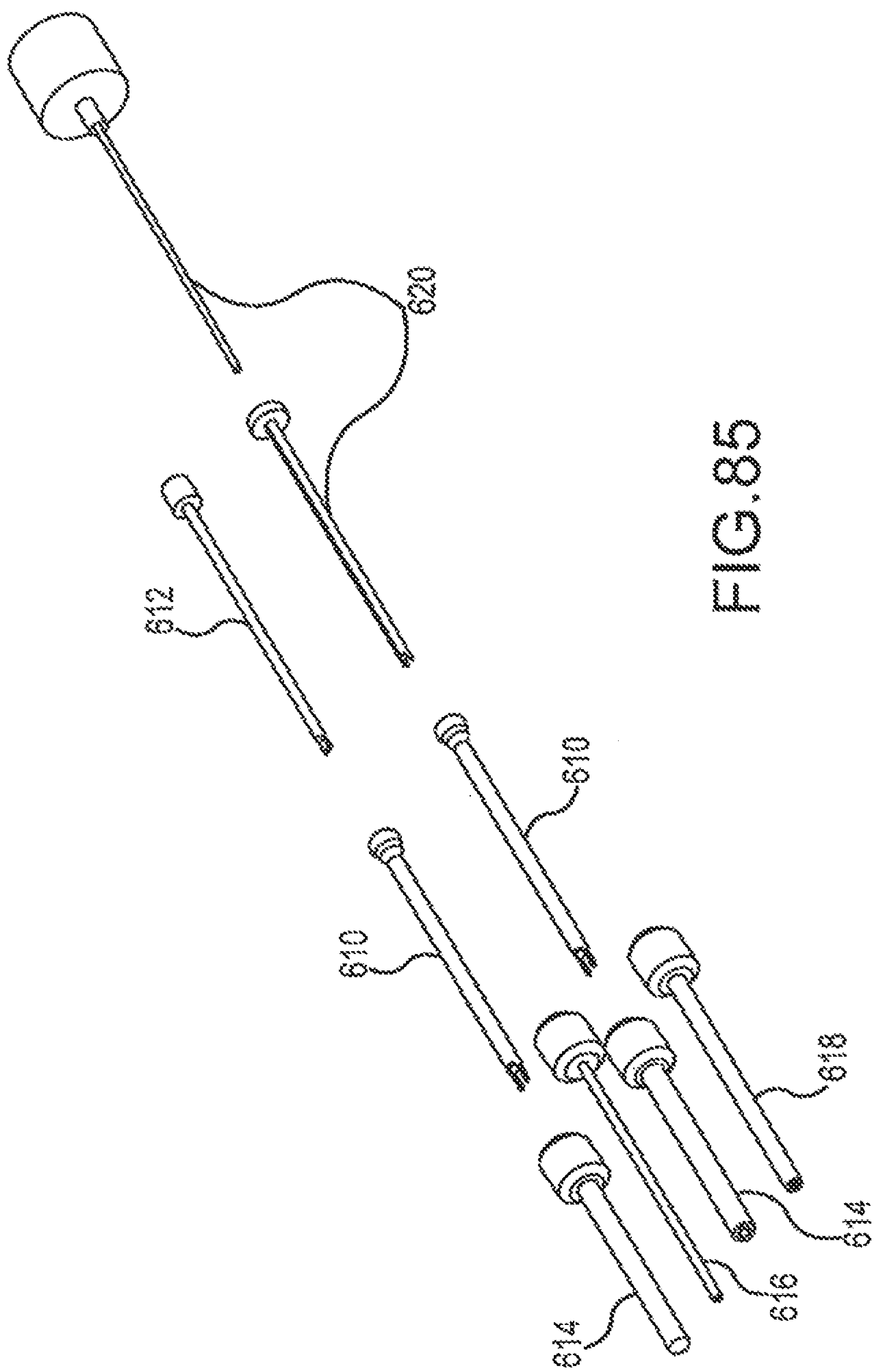


FIG.85

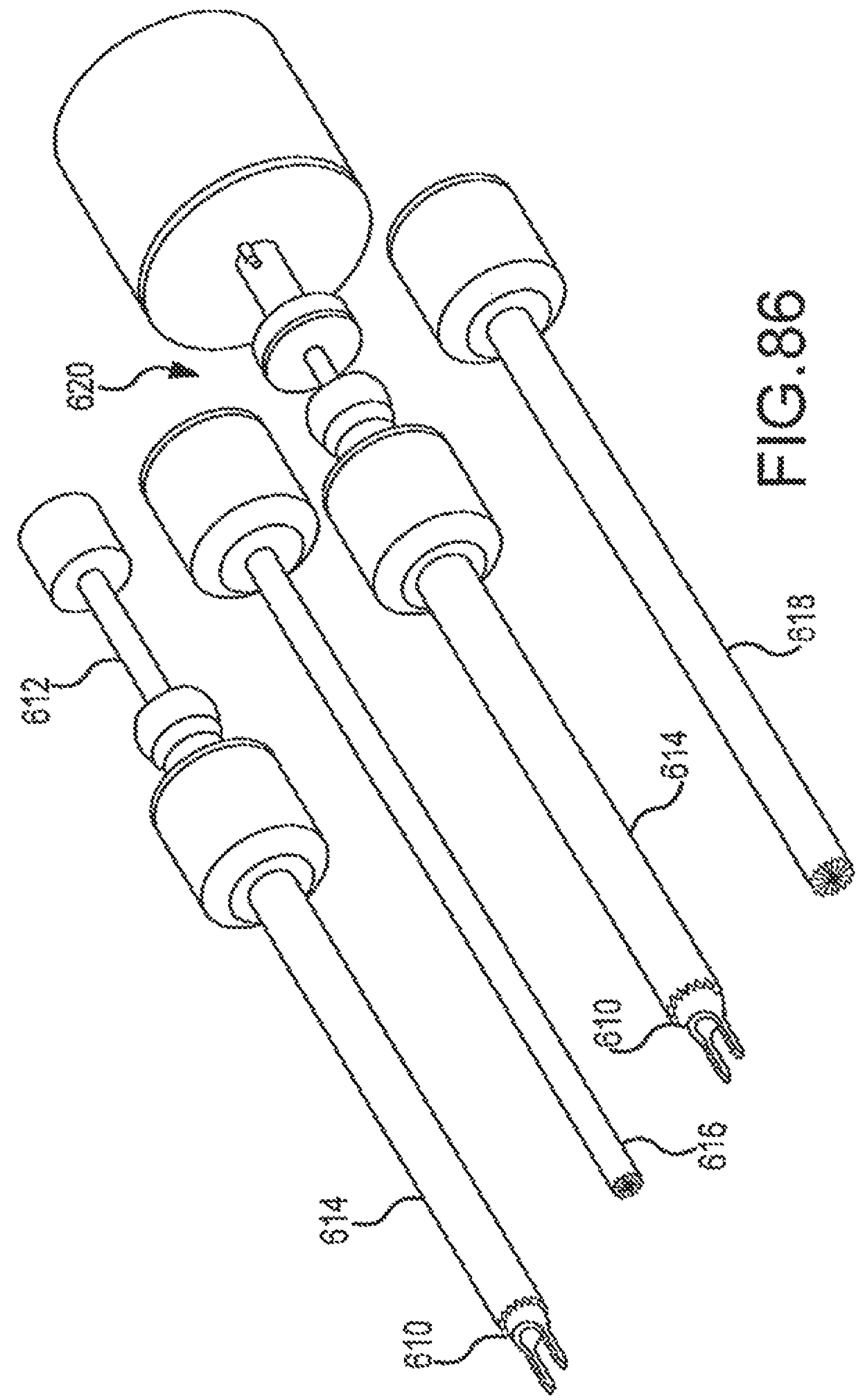


FIG.86

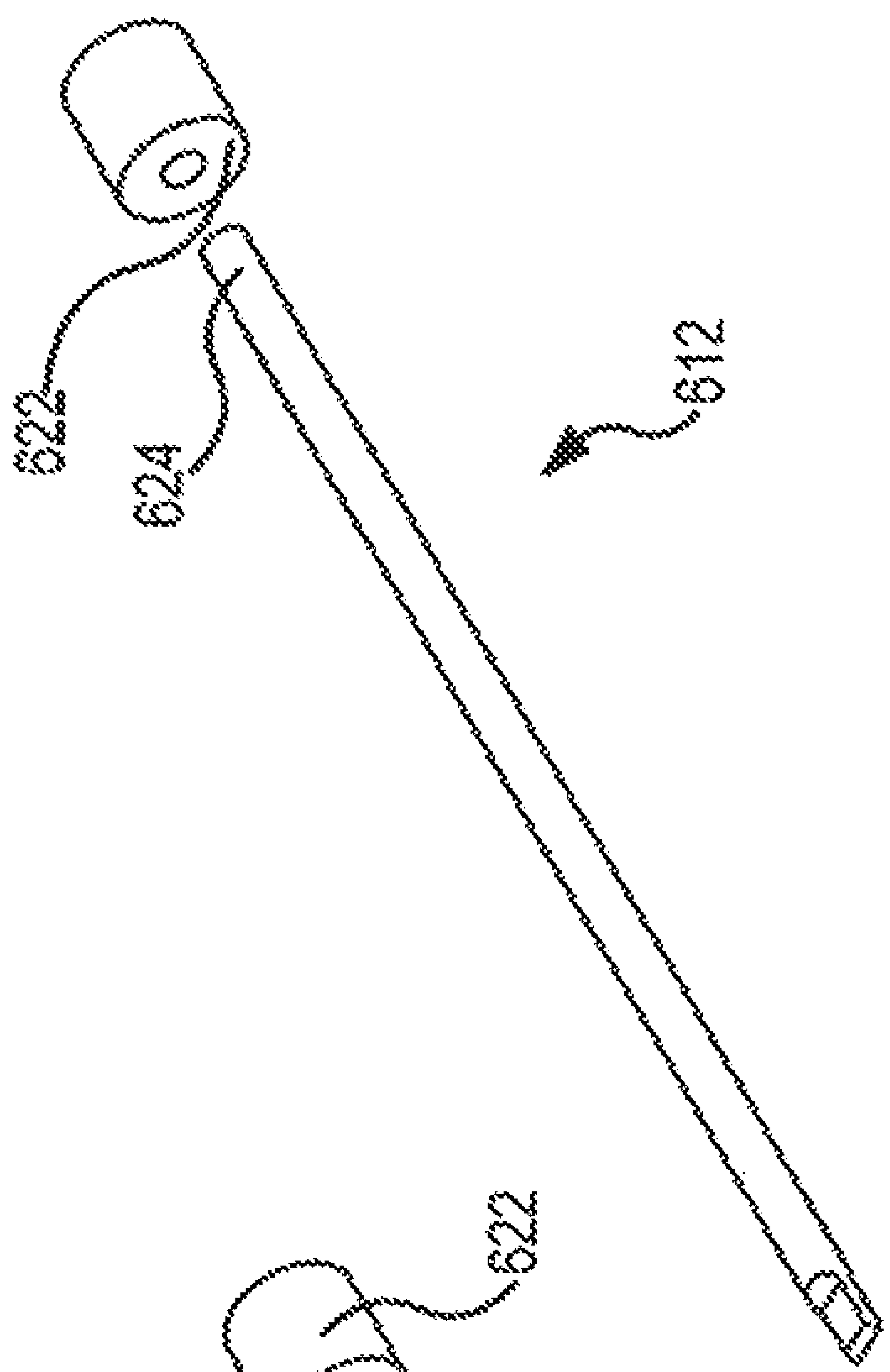


FIG.88

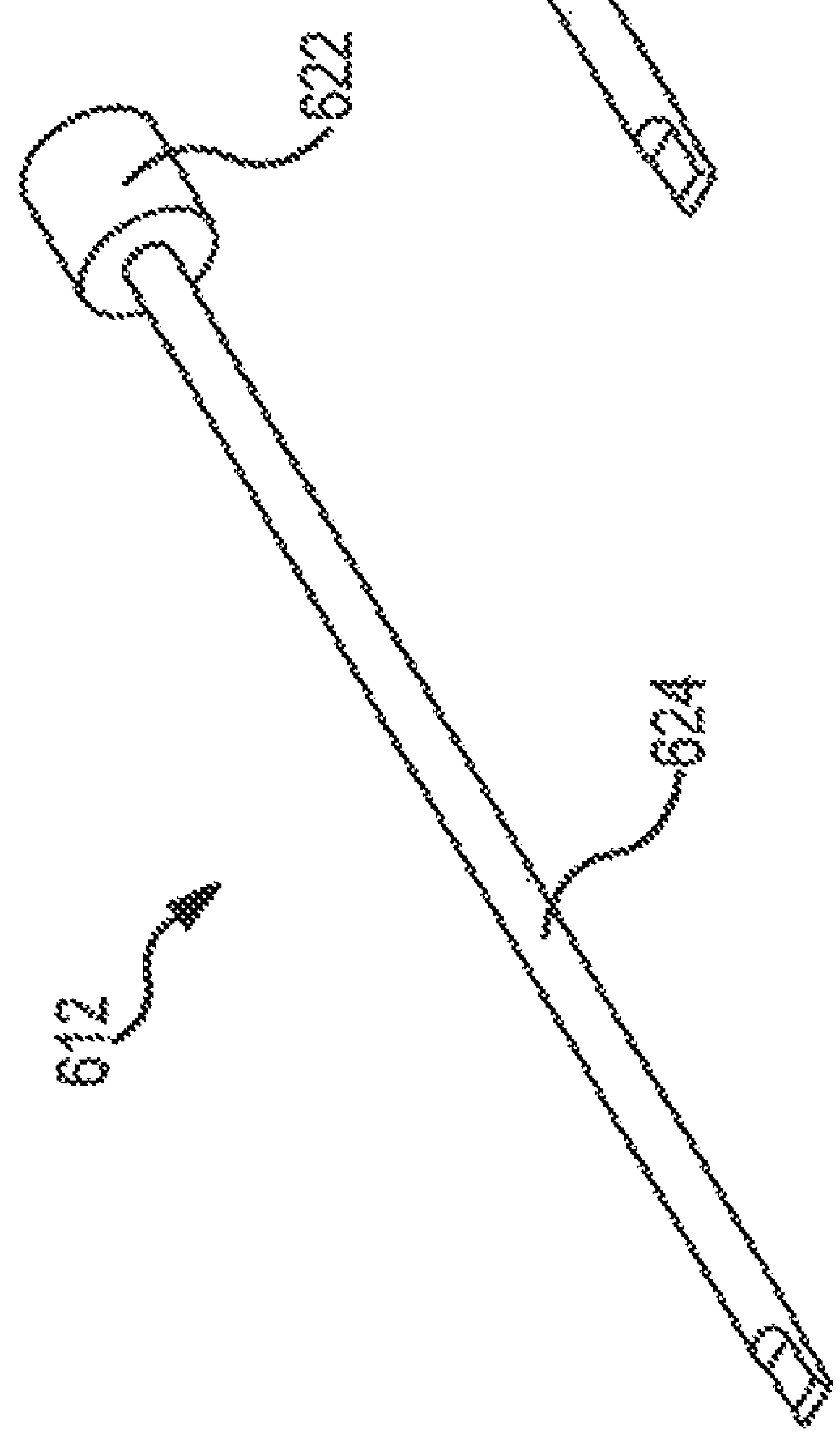


FIG.87

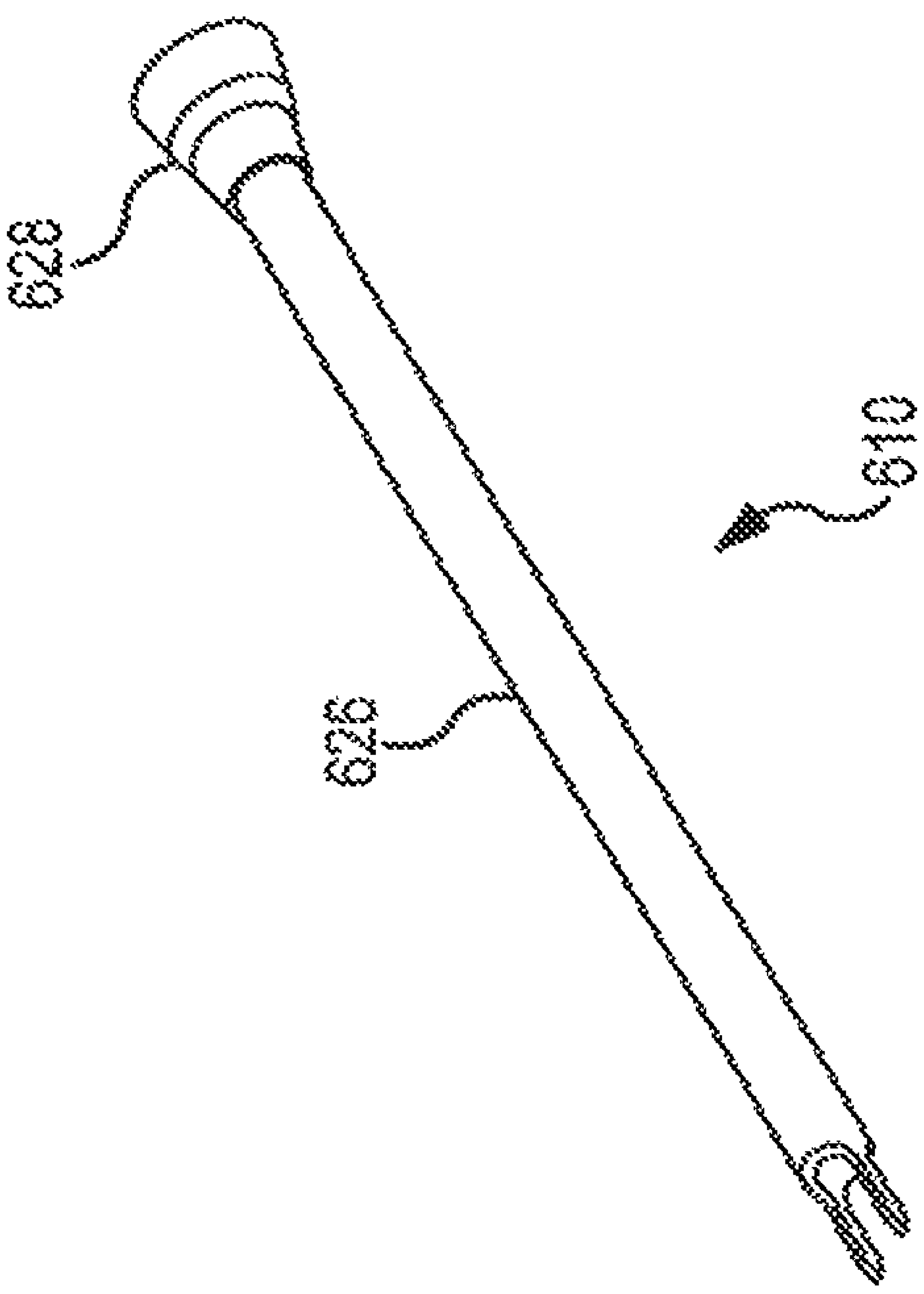


FIG.90

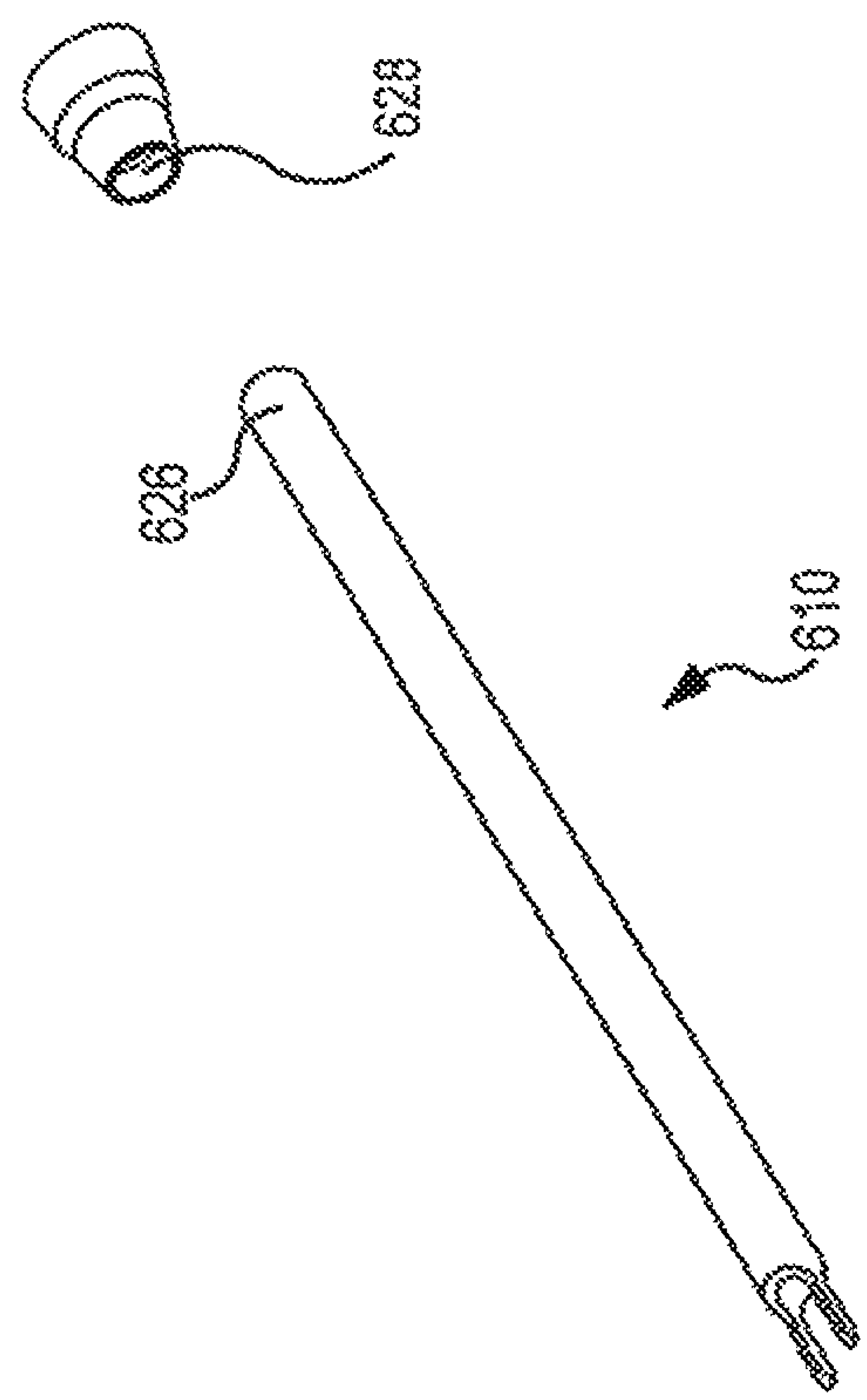


FIG.89

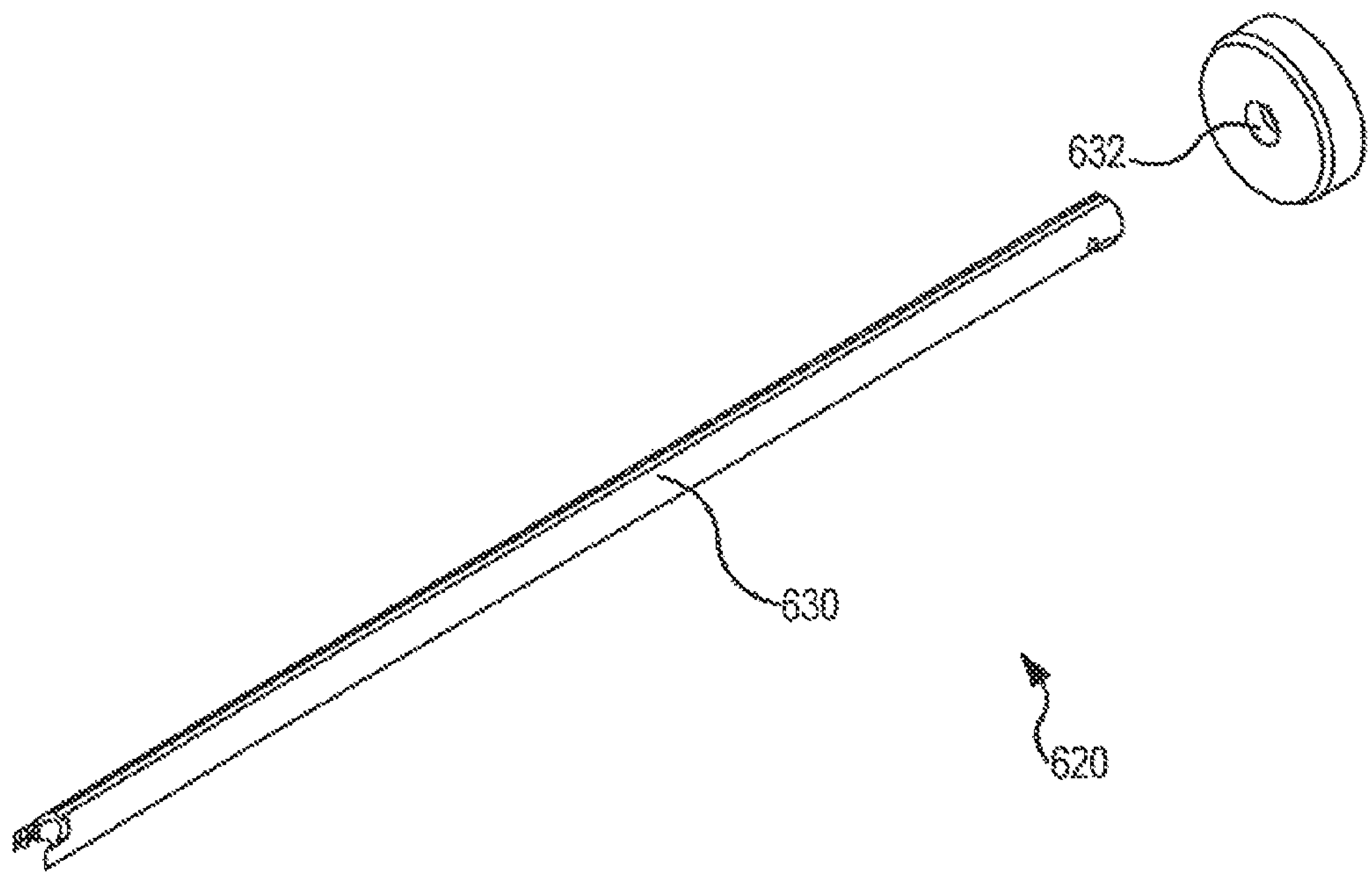


FIG.91

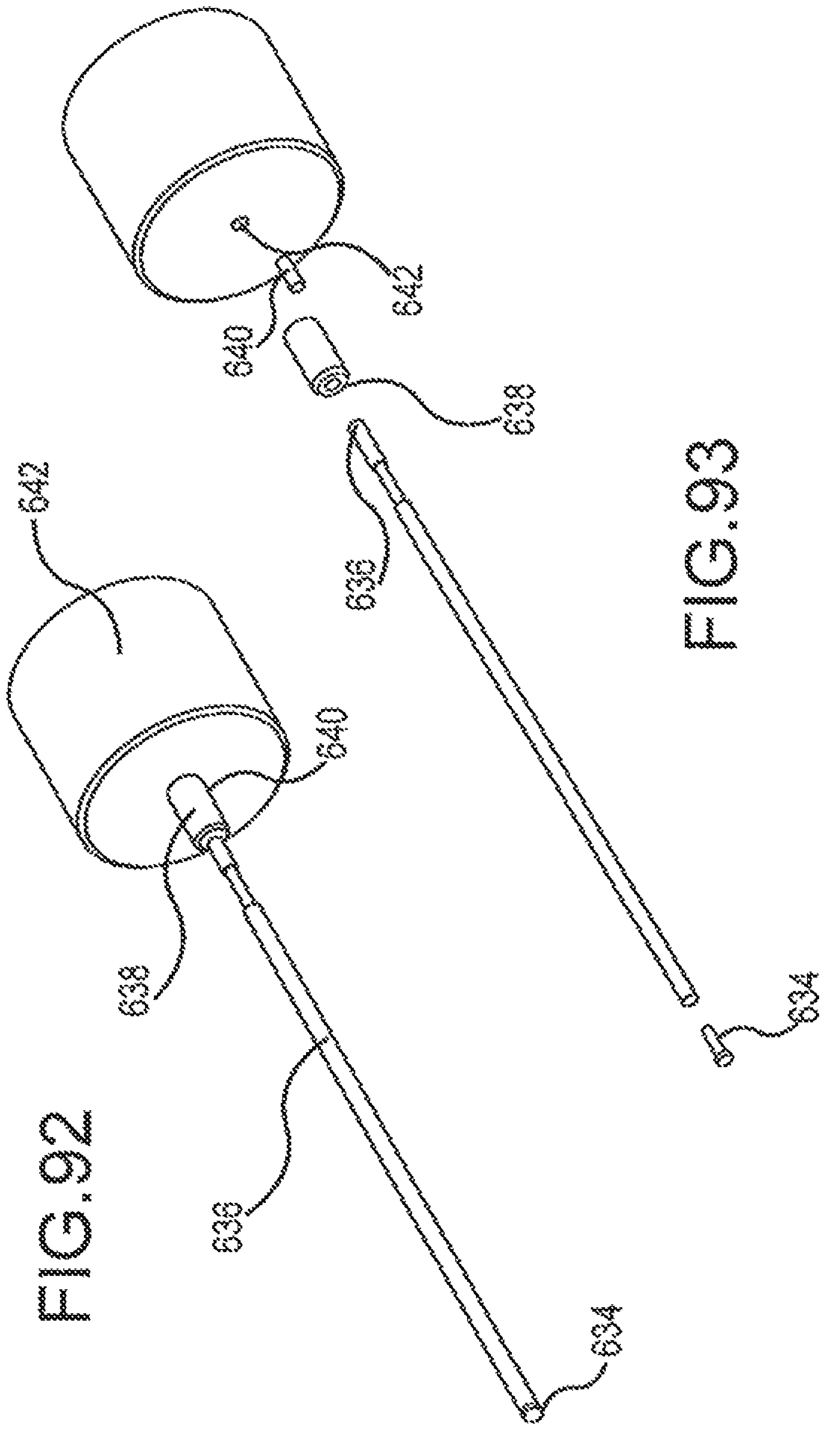


FIG.92

FIG.93

FACET JOINT IMPLANTS AND DELIVERY TOOLS

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a continuation application of Ser. No. 13/614,281, filed Sep. 13, 2012, entitled "FACET JOINT IMPLANTS AND DELIVERY TOOLS," now U.S. Pat. No. 9,011,492, which is a divisional application of Ser. No. 12/317,682, filed Dec. 23, 2008, entitled "FACET JOINT IMPLANTS AND DELIVERY TOOLS," now U.S. Pat. No. 8,267,966, which claims priority to U.S. Provisional Patent Application No. 61/109,776, entitled "FACET JOINT IMPLANTS," filed on Oct. 30, 2008 and U.S. Provisional Patent Application No. 61/059,726, entitled "SPINE DISTRACTION DEVICE," filed on Jun. 6, 2008. The full disclosures of the above-listed patent applications are hereby incorporated by reference herein.

FIELD

The following detailed description relates to a device for distracting the spine. More particularly the description relates to a tool for distracting a facet joint of the spine and an implant for maintaining the distracted position of the joint. More particularly the description relates to an implant that may be used together with a tool to distract a facet joint, the implant remaining in place separated from the tool. In some instances, the implant itself may extract the joint.

BACKGROUND

Chronic back problems cause pain and disability for a large segment of the population. Adverse spinal conditions may be characteristic of age. In particular, spinal stenosis (including, but not limited to, central, canal, and lateral stenosis) and facet arthropathy may increase with age. Spinal stenosis results in a reduction of foraminal area (i.e. the available space for the passage of nerves and blood vessels), which may compress cervical nerve roots and cause radicular pain. Both neck extension and ipsilateral rotation, in contrast to neck flexion, may further reduce the foraminal area and contribute to pain, nerve root compression, and neural injury.

Cervical disc herniations may be a factor in spinal stenosis and may predominantly present upper extremity radicular symptoms. In this case, treatment may take the form of closed traction. A number of closed traction devices are available that alleviate pain by pulling on the head to increase foraminal height. Cervical disc herniations may also be treated with anterior and posterior surgery. Many of these surgeries are performed through an anterior approach, which requires a spinal fusion. These surgeries may be expensive and beget additional surgeries due to changing the biomechanics of the neck. There is a three percent incidence of re-operation after cervical spine surgery. Moreover, these surgeries may be highly invasive leading to long recovery times.

There is a need in the art for a device and procedure to increase foraminal height to reduce radicular symptoms of patients suffering the effects of spinal stenosis. There is also a need for the device to be adapted to allow for the procedure to be minimally invasive and to avoid modifying the biomechanics of the spine.

BRIEF SUMMARY

In one embodiment, a spinal joint distraction system may include a driver assembly including a tubular shaft having a

longitudinal axis and a pair of implant holder arms positioned on a distal end of the tubular shaft, where the arms are configured to hold a spinal implant. In another embodiment, the driver assembly may also include an implant distractor positioned along the longitudinal axis near the distal end of the tubular shaft, an internal actuator positioned within the tubular shaft and adapted to advance the implant distractor, and a distractor knob adapted to control the internal actuator. In another embodiment, the system may also include a delivery device with a tubular shaft, a receiving assembly positioned on a proximal end of the tubular shaft, and a pair of forks extending from a distal end of the tubular shaft, where the may be adapted to penetrate a facet joint and the delivery device may be adapted to slidably receive the driver assembly. In some embodiments, the system may include an implant adapted for holding by the implant holding arms of the driver assembly. In some other embodiments, the system may include a chisel with a shaft portion, a tip at a distal end of the shaft, and a head at a proximal end of the shaft, where the delivery device is adapted to receive the chisel, and the head of the chisel is adapted to be tapped by a driving member to insert the tip of the chisel into a facet joint. In still other embodiments, the system may include an injector with a cannula with a closed distal end and two exit doors positioned on opposite sides of the distal end, a plunger with a seal positioned within the cannula, a stop disc at a proximal end of the cannula, and a handle positioned on a proximal end of the plunger, where the delivery device is further adapted to receive an injector.

In another embodiment, a spinal distraction implant may include an upper member and a lower member, the upper and lower member being generally rectangular and each having a distal edge, a proximal edge, and two parallel lateral edges, the upper and lower member positioned adjacent and substantially parallel to each other and having an inner surface and an outer surface, the distal edges of the upper and lower member connected to each other and the proximal edges adapted to receive an implant distractor, and teeth positioned along the lateral edges of at least one of the upper or lower member and extending outwardly. In another embodiment, the implant may include flanges extending substantially orthogonally from a proximal end of the upper and lower members. In some embodiments, the flanges may include openings for receiving anchors to anchor the implant to a lateral mass of a facet joint.

In another embodiment, a method of distracting a facet joint of the spine may include inserting a delivery device to access the facet joint of a patient, inserting a driver assembly holding an implant into the delivery device, and actuating the driver assembly thereby distracting the implant.

In another embodiment, a spinal distraction implant may include an upper member, a lower member, and a proximal member, the upper and lower members being generally rectangular and each having a distal edge and two parallel lateral edges, the upper and lower members extending generally continuously into each other to form the proximal member, the upper and lower member positioned adjacent and substantially parallel to each other and having an inner surface and an outer surface, the proximal member being generally perpendicular relative to the upper and lower members, at least one of the upper and lower members further including threaded slots adapted to receive threads of an implant distractor and outwardly extending teeth positioned along the lateral edges of at least one of the upper or lower members. In another embodiment, the proximal member may include a penetration for receiving an implant distractor.

In another embodiment, a spinal distraction implant may include a threaded bolt with a proximal end terminating in a head, a proximal non-threaded block positioned along the bolt and abutting the head of the bolt, a distal threaded block positioned a distance away from the proximal threaded block, and a plurality of expansion members positioned between the proximal and the distal threaded blocks. In one embodiment, the plurality of expansion members may be V-shaped members. In another embodiment, the plurality of V-shaped members may be adapted to deformably flatten out and expand laterally when compressed between the distal and proximal blocks. In another embodiment, the plurality of expansion members may be planar plates with slotted holes such that when freely positioned on the bolt, the plates are positioned in a skewed position relative to a longitudinal axis of the bolt. In another embodiment, the planar plates may be adapted to engage one another and thus position themselves perpendicular to the bolt when compressed between the distal and proximal blocks.

In another embodiment, a spinal distraction implant may include a pair of stacked structures separated by a sloping plane, the structures having an engagement surface along the plane including ratchet teeth. In one embodiment, a first structure of the pair of stacked structures increases in thickness in a proximal direction and a second structure of the pair of stacked structures increases in thickness in a distal direction.

In another embodiment, a spinal distraction implant may include a generally tapered shaft in the form of a screw, the shaft defining a longitudinal axis and having a length, the shaft having threads along an outer surface for engaging articular surfaces of a facet joint. In one embodiment, the threads may be notched along the length of the implant creating serrations for cutting into the articular surfaces of a facet joint. In another embodiment, the threads may include leaf springs for preventing backing out of the implant. In another embodiment, the threads may have a T-shaped cross-section. In another embodiment, the implant may include a relatively broad head with a decorticating feature on a distal surface thereof. In another embodiment, the decorticating feature may include tabs projecting distally from the head. In another embodiment, the decorticating feature may include spurs. In another embodiment, the head may be in the form of a floating collar and be free to pivot about the longitudinal axis of the implant in a ball and socket type fashion. In another embodiment, the implant may include a torque limiting mechanism. In another embodiment, the shaft may include a hollow cavity and take the form of a cone, the cone being made from a relatively malleable material, the implant further including an inner core support member for use when inserting the implant and for removal once the implant is in place. In still another embodiment, the generally tapered shaft may be a first tapered shaft and the implant may also include a second generally tapered shaft in the form of a screw where the second generally tapered shaft may be positioned adjacent to the first generally tapered shaft and have communicative threaded serrations such that when one shaft is rotated, the other shaft rotates in the opposite direction. In another embodiment, the implant may include an arm type locking mechanism, the arm being biased in a distal direction such that when implanted the arm provides a biasing force to maintain friction on the threads. In another embodiment, the arm may have engaging teeth. In another embodiment, the implant may include flaps extending from the head of the shaft and including teeth for engaging a lateral mass of a facet joint.

In another embodiment, a spinal distraction implant may include a plate and a orthogonally positioned bumper, the superior aspect of the bumper having a rounded surface for opposing the lateral mass of a superior vertebra, the implant including an anchoring screw for securing the implant to a lateral mass of a facet joint.

In another embodiment, a spinal distraction implant may include a wedge insertable between facet surfaces, the wedge having teeth on at least one of an anterior and inferior surface thereof. In another embodiment, the implant may also include a diagonally placed anchor screw positioned through the implant for advancing into the surface of a facet joint.

In another embodiment, a spinal distraction implant may include an anterior hook, a posterior hook, and a bolt joining the anterior and posterior hook. In another embodiment, the anterior hook may be C-shaped with a lip and the posterior hook may be S-shaped with a lip, the anterior hook adapted to engage the anterior aspect of the inferior facet and the posterior hook adapted to engage the posterior aspect of the posterior facet.

In another embodiment, a spinal distraction implant may include an insert and tabs positioned to extend orthogonally from a proximal end of the insert. In one embodiment, the insert may be rectangular and the tabs may have holes for receiving an anchor.

In another embodiment, a spinal distraction implant may include a collapsible diamond shaped structure including two opposing threaded corners, and two opposing non-threaded corners including pads. The implant may also include a bolt threaded through the threaded corners of the diamond shaped structure, where actuating the bolt draws the threaded corners together and extends the non-threaded corners.

In another embodiment, a spinal distraction implant may include an upper member, a lower member, a hinge connecting the upper member to the lower member, and a brace member for maintaining the implant in an open position.

In another embodiment, a spinal distraction implant may include a generally cylindrically shaped member including at least two sections separated by a slot, the sections connected together at distal ends to form a tip, the member adapted to receive a screw to cause it to expand, and the outer surface of the sections including teeth for engaging articular surfaces of a facet joint.

In another embodiment, a method of securing a superior vertebra may include applying a force to the superior vertebra to increase the foraminal area between the superior vertebra and an inferior vertebra and placing an angled screw through a superior facet, through a facet capsule, and into an inferior facet.

In another embodiment, a spinal distraction implant may include a collapsible triangular shaped implant including a central shaft and at least two springing leaves connected to the distal end of the shaft, extending proximally along the shaft, and biased in a direction to form an arrow shape, where the implant may be collapsed within a tube and delivered to a site where the tube is removed and the implant is allowed to expand.

In another embodiment, a spinal distraction implant may include a facet spacer plate and screw, wherein the screw may be inserted diagonally through a facet surface to engage the facet spacer plate thereby forcing separation of a facet joint. In another embodiment, the spacer may have a C-shape and the screw may pass through the spacer plate prior to entering the spinal structure.

In another embodiment, a spinal distraction implant may include a first bracket, second bracket, and a bolt extending between the brackets, where the brackets are adapted to separate when the bolt is turned. In another embodiment, the first and second brackets may be adapted to be attached to a lateral mass of a facet joint. In yet another embodiment, the first and second brackets may include a leg adapted to be inserted into a facet joint.

In another embodiment, a spinal distraction implant may include a triangular shaped wedge, an anchor screw positioned diagonally through the wedge, and a malleable flap extending from the wedge including teeth for engaging a lateral mass of a facet joint.

In another embodiment, a spinal distraction implant may include an anchoring plug, an expandable plate, and two external plates, where securing the external plates to a lateral mass of a facet joint and inserting the anchoring plug causes the facet joint to separate.

In another embodiment, a spinal distraction implant may include a delivery system and at least two nitinol hooks, where the hooks may be flattened and inserted with the delivery system and once in place may be allowed to assume their pre-flattened shape.

In another embodiment, a spinal distraction implant may include a hollow screw sleeve having barbs adapted to be ejected from a retracted position and a wedge adapted to be inserted in the hollow screw sleeve to eject the barbs.

In another embodiment, a spinal distraction implant may include a collapsible nut positioned over a bolt, the bolt defining a longitudinal axis, where advancing the bolt may cause the nut to collapse along the longitudinal axis in an accordion shape, thereby expanding laterally.

In another embodiment, a spinal distraction implant may include a collapsible plate positioned over a bolt, the bolt defining a longitudinal axis, where advancing the bolt causes the plate to collapse along the longitudinal axis in an accordion shape, thereby expanding laterally.

In another embodiment, a spinal distraction implant may include a wire surrounding a block in a helical fashion, the wire adapted to contract and expand laterally when pulled taught or released respectively.

In another embodiment, a spinal distraction implant may include an outer housing and an internal spring, where the housing may be biased to be in a laterally broad position when the spring is in a neutral position.

In another embodiment, a spinal distraction implant may include a pair of stacked structures separated by a sloping plane and a fastener positioned at an angle through the pair of structures thereby preventing relative movement along the plane.

In another embodiment, a spinal distraction implant may include a collapsible cylinder with side cutouts, the cylinder made from a resilient elastic material.

In another embodiment, a spinal distraction implant may include a distal tip of a delivery tool, where the tip is adapted to distract a facet joint and detach from the delivery tool.

In another embodiment, a spinal distraction implant may include a housing, a central gear rotatably positioned within the housing, and two plates slidably positioned in the housing and positioned opposite one another adjacent to the central gear and including teeth for engaging the gear, where rotating the gear slidably extends the plates beyond an outer surface of the housing in opposite directions.

In another embodiment, a spinal distraction implant may include a triangularly bent plate with a first and second bracket on each side, the first bracket adapted to receive an anchor screw and the second bracket including teeth for biting into a lateral mass of a facet joint.

In another embodiment, a spinal distraction implant may include a rotatable cone with a longitudinal axis including a shoulder with a ledge defining a cam surface and an anchor screw, where the shoulder is adapted to be inserted into a facet joint and the implant rotated to cause a superior facet to ride upward along the cam surface and distract the joint, wherein the screw may be advanced to secure the implant.

In another embodiment, a spinal distraction implant may include a housing with penetrations for ejection of spikes, internal spikes positioned with the housing and in alignment with the penetrations, and an internal wire routed through the spike positions, where pulling the wire taught forces the spikes from the housing to engage articular surfaces of a facet joint.

In another embodiment, a spinal distraction implant may include a housing, a cavity within the housing, penetrations on lateral surfaces of the housing extending from the cavity through the wall of the housing, spikes positioned to be ejected through the penetrations, the spikes having a beveled inner surface, and a piston having a torpedo shaped distal end positioned within the cavity, where advancing the piston engages the torpedo shaped distal end with the beveled inner surface of the spikes causing them to eject through the penetrations and engage articular surfaces of a facet joint.

In another embodiment, a spinal distraction implant may include two parallel equal length side bars and at least two struts pivotably positioned between the side bars at each end, the struts having textured surfaces on each end thereof, where the struts may be pivoted to lie in plane with and parallel to the side bars and once in position in a facet joint, may be pivoted substantially perpendicular to the side bars to distract the facet joint.

Further aspects of the invention will be brought out in the following portions of the specification, wherein the detailed description is for the purpose of fully disclosing preferred embodiments of the invention without placing limitations thereon.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be more fully understood by reference to the following drawings which are for illustrative purposes only:

FIG. **1** is a perspective view of a delivery device and chisel positioned relative to a facet joint of a spine, according to certain embodiments.

FIG. **1A** is a perspective view of a chisel according to certain embodiments.

FIG. **2** is a perspective view of a distal end of a delivery device, according to certain embodiments.

FIG. **3** is a perspective view of a distal end of a delivery device with an advanced chisel, according to certain embodiments

FIG. **4** is a perspective view of a distal end of a delivery device with an advanced internal decorticator, according to certain embodiments.

FIG. **5** is a perspective view of a delivery device and chisel positioned relative to a facet joint of a spine with a driving member positioned proximally to the chisel head, according to certain embodiments.

FIG. **6** is a perspective view of a delivery device with an exterior decorticator in an advanced position, according to certain embodiments.

FIG. **6**A-**6**C are perspective views of a delivery device and an internal decorticator, according to certain embodiments.

FIG. **7** is a perspective view of a delivery device with an exterior decorticator being retracted, according to certain embodiments.

FIG. **8** is a perspective view of a delivery device with a driver assembly and implant poised for insertion into the delivery device, according to certain embodiments.

FIG. **9** is a close-up view of a distal end of a driver assembly and a delivery device, according to certain embodiments.

FIG. **10** is close-up view of a distal end of a driver assembly, according to certain embodiments.

FIG. **11** is a perspective view of an implant and a distal end of a driver assembly, according to certain embodiments.

FIG. **12** is a perspective view of distal end of a driver assembly holding an implant, according to certain embodiments.

FIG. **13** is a perspective view of a distal end of a driver assembly positioned within a delivery device, according to certain embodiments.

FIG. **14** is a perspective view of an implant distractor, according to certain embodiments.

FIG. **15** is a perspective view of a distal end of a driver assembly positioned within a delivery device, according to certain embodiments.

FIG. **16** is a perspective view of an implant according to certain embodiments.

FIG. **16**A is a perspective view of an implant showing a guide feature, according to certain embodiments.

FIG. **16**B is a perspective view of an implant showing a guide feature, according to certain embodiments.

FIG. **17** is a side view of an implant according to certain embodiments.

FIG. **18** is a top view of an implant according to certain embodiments.

FIG. **18**A is a top view of an implant showing the guide feature of FIG. **16**A, according to certain embodiments.

FIG. **18**B is a top view of an implant showing the guide feature of FIG. **16**B, according to certain embodiments.

FIG. **19** is a proximal end view of an implant according to certain embodiments.

FIG. **20** is a side view of an implant according to certain embodiments.

FIG. **21** is side view of a U-member according to certain embodiments.

FIG. **22** is a perspective view of a U-member according to certain embodiments.

FIG. **23** is a perspective view of an implant according to certain embodiments.

FIG. **23**A is a perspective view of an implant according to certain embodiments.

FIG. **24** is a top view of an implant according to certain embodiments.

FIG. **24**A is a side view of the implant shown in FIG. **23**A, according to certain embodiments.

FIG. **25** is perspective view of a deliver device with a driver assembly inserted and advance, according to certain embodiments.

FIG. **26** is perspective view showing the removal of the driver assembly from the delivery device having left the implant behind, according to certain embodiments.

FIG. **27** is a perspective view of an injector, according to certain embodiments.

FIG. **28** is a perspective view of a delivery device with an advanced injector inserted and ejecting a material, according to certain embodiments.

FIG. **29** is a perspective view of an implant in a collapsed position according to certain embodiments.

FIG. **30** is a perspective view of an expanded implant according to certain embodiments.

FIG. **31** is a perspective view of an implant in a collapsed position according to certain embodiments.

FIG. **32** is a perspective view of an expanded implant according to certain embodiments.

FIG. **33** is a perspective view of an implant in a collapsed position according to certain embodiments.

FIG. **34** is a perspective view of an expanded implant according to certain embodiments.

FIG. **35** is a perspective view of an implant in a collapsed position according to certain embodiments.

FIG. **36** is a perspective view of an expanded implant according to certain embodiments.

FIGS. **37**A-D include side and perspective views of an implant, according to certain embodiments.

FIGS. **38**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **39**A-D include side and perspective views of an implant, according to certain embodiments.

FIGS. **40**A-C include side views of an implant, according to certain embodiments.

FIGS. **41**A-D include side and perspective views of an implant, according to certain embodiments.

FIGS. **42**A-F include side and perspective views of an implant, according to certain embodiments.

FIGS. **43**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **44**A-D include side and perspective views of an implant, according to certain embodiments.

FIGS. **45**A-D include side and perspective views of an implant, according to certain embodiments.

FIGS. **46**A-D include side and perspective views of an implant, according to certain embodiments.

FIGS. **47**A-B include side views of an implant, according to certain embodiments.

FIGS. **48**A-C include side and end views of an implant, according to certain embodiments.

FIGS. **49**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **50**A-B include side views of an implant, according to certain embodiments.

FIGS. **51**A-B include side views of an implant, according to certain embodiments.

FIGS. **52**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **53**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **54**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **55**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **56**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **57**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **58**A-B include side views of an implant, according to certain embodiments.

FIGS. **59**A-B include side views of an implant, according to certain embodiments.

FIGS. **60**A-B include side views of an implant, according to certain embodiments.

FIGS. **61**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **62**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **63**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **64**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **65**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **66**A-C include side views of an implant, according to certain embodiments.

FIGS. **67**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **68**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **69**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **70**A-C include side views of an implant, according to certain embodiments.

FIGS. **71**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **72**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **73**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **74**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **75**A-B include side views of an implant, according to certain embodiments.

FIGS. **76**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **77**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **78**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **79**A-C include side and perspective views of an implant, according to certain embodiments.

FIGS. **80**A-D include side and perspective views of an implant, according to certain embodiments.

FIGS. **81**A-C include side views of an implant, according to certain embodiments.

FIGS. **82**A-F include side and perspective views of an implant, according to certain embodiments.

FIGS. **83**A-B include side and perspective views of an implant, according to certain embodiments.

FIGS. **84**A-B include perspective views of an implant, according to certain embodiments.

FIG. **85** is an exploded perspective view of a kit, according to certain embodiments.

FIG. **86** is an assembled perspective view of a kit, according to certain embodiments.

FIGS. **87** and **88** are perspective views of a chisel portion of the kit shown in FIGS. **85** and **86**.

FIGS. **89** and **90** are perspective views of a delivery device portion of the kit shown in FIGS. **85** and **86**.

FIG. **91** is a perspective view of part of a driver assembly portion of the kit shown in FIGS. **85** and **86**.

FIGS. **92** and **93** are perspective views of a part of a driver assembly portion of the kit shown in FIGS. **85** and **86**.

DETAILED DESCRIPTION

The following description generally relates to devices and methods for treating spinal stenosis. Spinal stenosis reflects a narrowing of one or more areas of the spine often in the upper or lower back. This narrowing can put pressure on the spinal cord or on the nerves that branch out from the compressed areas. Individual vertebrae of the spine are positioned relative to each other and their separation is maintained by discs separating main vertebral bodies and by capsules positioned within facet joints. The discs and capsules are separated from the bone of their respective joints by cartilage. Spinal stenosis is often indicative of degeneration of a disc, a capsule, or the cartilage in a joint, which leads to a compression of the joints and the narrowing mentioned.

As such, the following detailed description includes discussion of a device for distracting a facet joint of the spine to remedy this condition. The device may include a tool and an implant for distracting and maintaining the distracted position of the joint. Several embodiments of an implant are described in addition to several embodiments of a tool. In addition, several embodiments are described where the implant and the tool work together to distract the facet joint and thereafter leave the implant behind to maintain the distraction of the joint. In short, the device may be adapted to access a facet joint by inserting a delivery tool and an implant, forcibly separate the associated articular surfaces with the tool, the implant, or both, and leave the implant in place to maintain the separation of the articular surfaces. This approach may allow for maintaining the distraction of the joint, thereby relieving symptoms associated with spinal stenosis.

The present application hereby incorporates the following U.S. patent applications by reference herein in their entireties: U.S. patent application Ser. No. 11/618,619, which was filed on Dec. 29, 2006 and is entitled Cervical Distraction Device; U.S. Provisional Patent Application No. 61/020,082, which was filed on Jan. 9, 2008 and is entitled Methods and Apparatus for Accessing and Treating the Facet Joint; U.S. Provisional Application No. 61/059,723, which was filed on Jun. 6, 2008 and is entitled Spine Distraction Device; U.S. Provisional Application No. 61/097,103, which was filed on Sep. 15, 2008 and is entitled Cervical Distraction/Implant Delivery Device; and U.S. Provisional Application No. 61/109,776, which was filed on Oct. 30, 2008 and is entitled Facet Joint Implants.

Referring now to FIGS. **1-28**, a first embodiment of a tool and an implant is shown. FIG. **1** shows the tool **100** in position posterior to the spine **102**. The tool **100** includes a delivery device **104**, a decorticator **106**, and a chisel **108**.

The delivery device **104** may include a receiving assembly **110** at a proximal end, anchoring forks **112** at a distal end, and a generally tubular shaft **114** defining a longitudinal axis and extending between the receiving assembly **110** and the anchoring forks **112**. The tubular shaft **114** may have an annular shaped cross-section with an inner radius and an outer radius, where the difference between the two radii defines a thickness of the tubular shaft **114**.

The receiving assembly **110** of the delivery device **104** may have a generally conical outer surface defining a generally hollow volume or solid mass. The conical outer surface may have a longitudinal axis that coincides with that of the tubular shaft **114**. The conical outer surface may be defined by a first radius at a proximal end and a second radius at a distal end. Where the tubular shaft **114** and the receiving assembly **110** are manufactured as one piece, the second radius may match the outer radius of the tubular shaft. Alternatively, the distal end of the receiving assembly **110** may be adapted for a press fit over the proximal end of the tubular shaft **114**. The receiving assembly **110** may also include a longitudinally extending bore **116** having an inner radius matching that of the tubular shaft **114** or may have a conically shaped inner surface leading to the tubular shaft **114**. The receiving assembly **110** may also include a relatively thin annular ring **118** offset from its distal end by two relatively thin extension elements **120**. The space between the proximal end of the conical portion of the receiving assembly **110** and the distal end of the annular ring **118** may define an access opening **122**.

In another embodiment as shown in FIGS. **6**A-**6**C, a receiving assembly **111** may not include the annular ring **118** and the extension elements **120**, but may remain generally conical and may include the longitudinally extending bore **116**. In addition, near the proximal end of the receiving assembly **111**, seating recesses **119** may be included. These recesses **119** may be positioned on opposing sides of the bore **116** and may recess into the proximal end of the receiving assembly **111** and the inner surface of the bore **116**. These recesses may function to receive positionally matched protrusions from any one or all of the devices being inserted into the deliver device. As such, the recesses **119**, may allow for orienting the devices properly relative to the forks **112** positioned in the facet joint. It is noted that any number of recesses may be provided and that any orientation may be used, either symmetrical or non-symmetrical, such that one or several orientations may be controlled. That is, an asymmetrical arrangement may allow for only one proper insertion position as opposed to the symmetrical orientation shown, which may allow for two proper insertion positions.

As shown in more detail in FIG. **2**, the delivery device **104** may include two anchoring forks **112** formed by coping two opposing portions of the distal end of the tubular shaft **114**. The forks **112** may have a generally V-shaped tip **124** at their distal end and may have a generally rectangular cross-section extending from the V-shaped tip **124** to the proximal end of the forks **112**. The rectangular cross-section may have an inside face and an outside face where the inside face faces the longitudinal axis of the delivery device **104**. The rectangular cross-section may also have opposing surfaces connecting the inside face to the outside face and completing the rectangular cross-section. At the proximal end of the forks **112**, as suggested by the coping mentioned above, the cross-section may gradually change from rectangular to a shape matching that of half of the annular shape of the tubular shaft portion. The forks **112** may also include serrations or teeth along the opposing surfaces to assist with anchoring the delivery device **104**.

Referring again to FIG. **1**, the chisel **108** may have a generally cylindrical cross-section forming a shaft **128**. The shaft **128** may have a radius substantially equal to the inner radius of the tubular shaft **114** portion of the delivery device **104** allowing for slidable insertion of the chisel **108** within the delivery device **104**. The chisel **108** may include a basic single or doubly chamfered tip **130** at a distal end or may have a coped distal end. The chisel **108** may also include a head **132** at a proximal end. The head **132** may be a generally solid material and may have a generally flat distal face and a spherically shaped proximal face. The shaft **128** and tip **130** portion of the chisel **108**, measured from the distal face of the head **132** to the distal end of the chamfered tip **130**, may have a length substantially equal to the distance from a proximal face of the annular ring **118** of the delivery device **104** to the distal tip of the delivery device **104**.

In another embodiment, the chisel **108** may include a longitudinal lumen **131** as shown in FIG. **1**A. While not shown, this embodiment may also include the head **132** shown in FIG. **1** and the lumen **131** may extend there through. The lumen **131** in the chisel **108** may be used for advancing a scope along with the chisel **108** to properly place the chisel **108** and the delivery device **104**. The lumen **131** may also be used to provide suction or fluid flushing to the surgical site to remove or flush debris created by inserting the serrated forks **112** of the delivery device **104** and the tip **130** of the chisel **108**.

As shown in FIG. **3**, the tip **130** of the chisel **108** may have a coped shaped similar to that of the forks **112** of delivery device **104**. In this condition, the tip **130** may include a generally V-shaped distal end matching that of the forks **112**. The tip **130** may have a width substantially equal to twice the inner radius of the tubular shaft **114** of the delivery device **104** such that the tip **130** extends between the two inside faces of the forks **112**.

Referring again to FIG. **1**, the decorticator **106** may have a tubular shaft **134** portion, an abrasive distal end **136**, and a handle **138** at a proximal end. The tubular shaft **134** may have an inner radius substantially equal to the outer radius of the tubular shaft **114** of the delivery device **104** and may allow for sliding movement of the decorticator **106** along the length of the delivery device **104** and rotationally around the delivery device **104**. The abrasive distal end **136** may include serrated teeth as shown, or may include a more flat annular surface with a gritty surface. The handle **138** may have a generally cylindrical portion with randomly or patterned raised portions or recesses adapted to assist gripping the handle. The proximal and distal ends of the handle **138** may be generally spherical. It is noted that the decorticator **106** may alternatively be separate from the delivery device **104** and may be slidably inserted within the delivery device **104** as shown in FIG. **4**. In this embodiment, the decorticator **106** may be inserted, advanced to the implantation site, and rotated similar to the decorticator **106** described above to roughen the bone surface.

In still another embodiment, a decorticator **106** may take the form of a relatively sharp pick, as shown in FIG. **6**A-**6**C. As shown in FIG. **6**A, the decorticator **106** may include a control handle **139** for advancing and pivoting the device. The control handle **139** may be connected to a tubular shaft **135**, which may be connected to a sharp flexible tip **137**. As shown, the tip **137** may be relatively thin and may have a neutral position relative to the longitudinal axis of the delivery device **104** so as to position the tip **137** within the boundary defined by the inner surface of the delivery device **104**. As such, when inserted in the delivery device **104**, the tip **137** may slide readily through the delivery device **104**. When the decorticator **106** is advanced to the distal end of the delivery device **104**, the tip **137** may be rotated and maneuvered to decorticate the surface of the lateral mass. It is noted that the shaft **135** may be relatively narrow when compared to the inner bore of the delivery device **104** to facilitate better maneuverability of the tip of the decorticator as it extends out the end of the deliver device. The decorticator may be used as shown in FIGS. **6**B and **6**C to rotationally scrape or longitudinally penetrate the lateral mass of a facet joint. A driving member may be used to assist the decorticating process.

Referring now to FIG. **5**, the tool **100** is shown with the chisel **108** fully inserted into the delivery device **104** such that the distal face of the head **132** of the chisel **108** is in abutting relationship with the annular ring **118** of the receiving assembly **110** on the delivery device **104**. The distal tip **130** of the chisel **108** thus extends to the distal end of the delivery device **104**. A hammer **140** is shown for use in tapping the proximal end of the chisel **108** and thus advancing the forks **112** of the delivery device **104** and the tip **130** of the chisel **108** into the facet joint. As the chisel **108** and the delivery device **104** are advanced into the joint, the forks

112 of the delivery device may channel into the fact surface and displace or remove tissue. In some embodiments, this may be removed by a suction lumen in the chisel. Once the chisel **108** and delivery device **104** are tapped into place, the chisel **108** may be removed and the serrations on the opposing surfaces of the forks **112** may aid in anchoring the delivery device **104** in the joint and preventing dislodgement.

FIG. **6** shows the decorticator **106** in an advanced position along the length of the delivery device **104** such that the distal end is in contact with the bone surfaces surrounding the facet joint. The handle **138** is being used to rotate the decorticator **106** around the perimeter of the delivery device **104** to roughen the associated bone surfaces. Alternatively, either of the internal decorticators shown in FIG. **4** or **6**A-**6**C may be used.

FIG. **7** shows the decorticator **106** retracted and also shows the resulting roughened bone surfaces.

Referring now to FIG. **8**, the tool **100**, including the delivery device **104** and retracted decorticator **106**, is shown lodged in a facet joint. Also shown is a driver assembly **142** portion of the tool **100**. The driver assembly **142** includes a distractor knob **144**, an implant shaft **146**, implant holding arms **148**, an implant distractor **150**, and an internal actuator **152** (not shown). The driver assembly **142** shown is holding an implant **154** and is poised for insertion into the delivery device **104**.

Referring now to FIGS. **9**-**15** several views of the driver assembly **142** are shown. In FIG. **9**, a portion of the delivery device **104** is shown for receiving the driver assembly **142**. The distal end of the driver assembly **142** is also shown. FIG. **10** shows a close-up view of the distal end of the driver assembly **142** where the implant **154**, the implant distractor **150** and the internal actuator **152** are not shown. As shown, the implant shaft **146** of the driver assembly **142** defines a longitudinal axis thereof and has a generally annular cross-section with an inner radius and an outer radius where the difference between the two radii defines the wall thickness of the shaft **146**. The outer radius of the implant shaft **146** is substantially equal to the inner radius of the tubular shaft **114** of the delivery device **104**. The implant shaft **146** also includes a keyway feature **156** for preventing relative rotation between the tubular shaft **114** of the delivery device **104** and the implant shaft **146** of the driver assembly **142** when inserted. As shown, the keyway feature **156** may include a pair of tabs on opposing sides of the implant shaft **146** for engaging with a corresponding longitudinal slot in the inner surface of the tubular shaft **114** of the delivery device **104**. In another embodiment, this keyway feature **156** may be in the form of a longitudinal slot in the outer surface of the implant shaft **146** of the driver assembly **142**, as shown in FIG. **11**, which may receive an internal ridge, tab, or other protrusion from the inner surface of the tubular shaft **114** of the delivery device **104**.

With continued reference to FIG. **10**, two arms **148** are shown extending from the distal end of the implant shaft **146**. The arms **148** may be formed by coping opposing surfaces of the implant shaft **146**. As shown, the arms **148** have a generally rectangular cross-section with an inside face facing the longitudinal axis of the implant shaft **146** and an opposite outside face. The inside and outside faces of the cross-section are connected by two opposing faces. The arms **148** may include an engagement feature **158** at a distal end for engaging an implant **154**. As shown, the engagement feature **158** may include a generally rectangular element positioned orthogonal to the arms **148** and flush with the outside face of the arms. As shown in FIG. **9**, the implant **154** may slide over the distal end of the arms **148** and may include a receiving feature **160** for receiving the engagement feature **158** of each of the arms **148**.

Referring now to FIG. **11**, another embodiment of the arms **148** is shown in relation to an implant **154**. In this embodiment, the arms **148** may still be formed by coping opposing surfaces of the implant shaft **146**. In this embodiment, the outside face of the arm **148** may be a continuation of the outside surface of the implant shaft **146**. However, the inside face of the arm **148** is more detailed than that of the embodiment shown in FIG. **10**. That is, as shown in FIG. **11**, the inside surface may include a longitudinal ridge **162** extending the length of the arm **148**. The arm **148** may also include a bull nose engagement feature **158** extending transverse to the longitudinal axis of the implant shaft **146** along the inside face of the arm **148**. As shown in FIG. **12**, where the arms **148** are engaged with and holding the implant **154**, the longitudinal ridges **162** of each arm **148** are positioned between upper and lower planar members of the implant **154** and the bull nose engagement features **158** are positioned in the U-shaped receiving feature slots **160** on the lateral edges of the implant **154**.

The implant distractor **150** is shown in FIG. **9** and a close-up view is shown in FIG. **14**. The implant distractor **150** may be a generally narrow conical element tapered to a point at a distal end. At a proximal end, the implant distractor **150** is shown to include an extruded hexagon shape **164**. In the present embodiment, the outer surface of the implant distractor **150** includes a continuous coil-shaped thread feature **166**. The implant distractor **150** is shown positioned proximal to the implant **154** and engaged by the internal actuator **152**. Those of skill in the art will understand and appreciate that the implant distractor **150** may take on a variety of shapes and sizes other than that shown in the present embodiment. For example, the implant distractor **150** may be a triangular shaped wedge, a generally conical shape without threads, or other shape adapted to cause separation and distraction of a facet joint.

Referring again to FIG. **9**, the internal actuator **152** is visible extending from the distal end of the implant shaft **146**. The internal actuator **152** generally includes a longitudinal shaft positioned within the driver assembly **142**. The internal actuator **152** may have a radius substantially equal to the inner radius of the driver assembly **142** and may be adapted for slidable longitudinal and rotational movement relative to the driver assembly **142**. The internal actuator **152** may be moved relative to the implant shaft **146** longitudinally, rotationally, or both via the distractor knob **144** and may cause a corresponding motion of the implant distractor **150**. As such, the internal actuator **152** may advance the implant distractor **150** into the implant **154** thus expanding the implant **154** in the joint causing distraction of the joint. The distal end of the internal actuator **152** may include a hex driver type tip as most clearly shown in FIG. **15** for engaging the extruded hexagonal shaped proximal end of the implant distractor **150**. Those skilled in the art will understand and appreciate that several driving engagements are known in the art including flat screwdriver types, phillips head types, square drive, etc. and that these are within the scope of the invention.

In one embodiment, when the driver assembly **142** is inserted, it may carry the internal actuator **152**, the implant distractor **150**, as well as the implant **154** with it. However, to properly position the driver assembly **142** and the implant **154**, some force may be required via a mallet or other member driving member. In this embodiment, the internal actuator **152** may be slightly isolated from the driver assembly **142**, so as to avoid advancing the internal actuator **152**, and thus the implant distractor **150**, when forcing the driver assembly **142** into the joint. This isolation may help to avoid inadvertently advancing the internal actuator **152** and the implant distractor **150**, thus avoiding inadvertent distraction prior to proper placement. The isolation of the internal actuator **152** from the driver assembly may take the form of a loosely fitting threaded engagement between the driver assembly **142** and the internal actuator **152**. Alternatively, this isolation may be in the form of a clip between the two features.

For a detailed discussion of an implant **154** according to certain embodiments, reference is now made to FIGS. **16-24**.

As can be understood from FIGS. **16** and **17**, the implant **154** may include upper **168** and lower **170** members. The members **168**, **170** may be generally planar and may also be generally rectangular. As most clearly shown in FIG. **18**, each of the upper **168** and lower **170** members may include a proximal edge **172**, a distal edge **174**, and a pair of parallel lateral edges **176** extending longitudinally between the distal edges **174** and the proximal edges **172**. The distal **174** and proximal edges **172** may be generally square edges, while the lateral edges **176** may be defined by a radiused curve. As shown in cross-section in FIG. **19**, the inner surface **178** of the upper **168** and lower **170** member may be generally flat as it approaches the lateral edge **176**. Gradually, the inner surface **178** departs from generally flat and follows a radiused curve until it intersects with the outer surface **180**. The members **168**, **170** may be joined at their respective distal edges **174** by a U-member **182** to form a leading end. Alternatively, as shown in FIGS. **23** and **24**, the leading end may be formed via a weld (not shown) that couples the distal edges **174** of the planar members **168**, **170** together. In yet another embodiment, the upper **168** and lower **170** members may be formed from a single plate bent to create the implant as shown in FIGS. **23**A and **24**A. In any or all of these embodiments, the planar members **168**, **170** may be biased by the leading end to be generally parallel to each other, the inner faces **178** of the planar members **168**, **170** facing each other in an opposed fashion and abutting or nearly abutting each other. A guide feature **184** may be included on each of the upper **168** and lower **170** members as well as teeth **186** projecting outwardly from the outer faces **180** of the members **168**, **170**. The receiving features **160** mentioned above with respect to FIGS. **11** and **12** may also be included. Threaded slots **188** may also be included in each planar member **168**, **170** for receiving the coil-shaped thread feature **166** on the implant distractor **150**.

With continued reference to FIGS. **16** and **17**, the guide feature **184** may take the form of a half-conical feature and may be positioned at or near the proximal edge **172** of each of the upper **168** and lower **170** members. The half-conical feature may begin at the proximal edge **172** with the widest radius of the half-conical feature and may taper to a zero or approximately zero radius as the half-conical feature extends in the direction of the distal edge **174**. Where the upper **168** and lower **170** members are in parallel position, the half conical features may oppose one another and function to receive and guide an advancing implant distractor **150**. As such, like the upper **168** and lower **170** members described above, the half-conical features may also include threaded slots **188** for receiving the coil-shaped thread feature **166** on the implant distractor **150**. In other embodiments, the half-conical feature may not actually be a full half cone. Instead, the proximal end of the feature may be a segment of a circle and the feature may be relatively subtle in the form of a cone segment. In another embodiment the guide feature **184** may include a V-shaped notch or a rectangular notch in the proximal end of the upper **168** and lower **170** members as shown in FIGS. **16**A and **18**A and FIGS. **16**B and **18**B respectively. Those skilled in the art will understand and appreciate that other shaped notches or elements may be positioned on proximal end of the upper **168** and lower **170** members to guide the implant distractor **150**, and these elements are within the scope of the present disclosure.

As shown, the upper **168** and lower **170** members may also each include teeth **186** projecting outwardly (e.g. a direction opposite the position of the other upper or lower member) from the outer surfaces **180** of the upper **168** and lower **170** members. As shown in FIG. **17**, the teeth **186** may be equally spaced along each lateral edge **176** and may have a linearly sloped distal face **190** and a proximal face **192** oriented orthogonally to its respective upper **168** or lower **170** member. The distal face **190** and proximal face **192** may intersect to form a point **194**. The teeth **186** may also be bounded by opposing inside **196** and outside **198** lateral faces separated by a thickness approximately equal to the thickness of the upper **168** and lower **170** members. As shown in FIG. **19**, the outside face **198** of the teeth **186** follows an extension of the radiused curve formed by the inner surface **178** of the upper **168** or lower **170** member at the lateral edge **176**, this curve being referred to as a first radiused curve. Additionally, the inside face **196** of the teeth **186** follows a second radiused curve offset from the first radiused curve, such that the teeth **186** have a generally constant thickness from the location where they depart from the outer surface **180** of the upper **168** or lower **170** member to the point **194**. The radiused shape of the teeth **186** allows the implant **154** to slidably engage the inside of the delivery device **104** when it is advanced toward the implantation site. Those skilled in the art will understand and appreciate that one, as opposed to both, of the upper **168** and lower **170** members may include teeth **186** to facilitate freedom of motion of the facet joint once the implant **154** is in place.

As shown in FIGS. **16** and **17**, where a U-member **182** is used to connect the upper **168** and lower **170** members, the U-member **182** may overlap the upper **168** and lower **170** members. Alternatively, as shown in FIG. **20**, the U-member **182** may attach to the distal ends **174** of the upper **168** and lower **170** members via a butt joint. In either case, the U-member **182** may be fastened via welding, fusing, or other techniques known in the art. As shown in FIGS. **21** and **22**, the U-member **182** may be a relatively thin, generally rectangular piece of material formed into the shape of the letter 'U'. The rectangular piece of material may have a length defined by the amount of overlap of the upper member **168** and the lower member **170** in addition to the length associated with hairpin or U portion of the member **182**. The width of the rectangular plate may be substantially equal to the distance between the teeth **186** of the upper **168** and lower **170** members. The U-member **182** may be adapted to provide the parallel biased position mentioned and yet allow distraction of the upper **168** and lower **170** member when a separation force is applied, the proximal edge **172** of the upper **168** and lower **170** member distracting more than the distal edge **174**.

As shown in FIGS. **23** and **24**, where the distal edges **174** of the upper **168** and lower **170** member are joined via welding, the distal edges **174** may include a notch to facilitate more weld length and to cause flexure to occur in the upper **168** and lower **170** members rather than in the weld itself. Also shown in FIGS. **23** and **24** are the U-shaped receiving feature slots **160** for receiving the bull nosed engagement features **158** of the arms **148** of the driver assembly **142**. As shown most clearly in FIG. **24**, the U-shaped receiving feature slots **160** are positioned between the equally spaced teeth **186** and extend into the lateral edges **176** of the upper **168** and lower **170** member just beyond the inside edge of where the teeth **186** begin extending from the outer surfaces **180**.

The receiving feature **160** may take several forms including a rectangular notch in the lateral edge **176** of the upper **168** and lower **170** member or a U-shaped notch. The receiving feature **160** may be adapted to receive an engagement feature **158** positioned on the arm **148** of the driver assembly **142**. The receiving feature **160** may be any shaped recess and may be adapted to be engaged by the engagement feature **158** so as to prevent or limit relative longitudinal motion between the arms **148** and the implant **154**, when the implant **154** is in the neutral position. However, when in an expanded or distracted position, the receiving features **160** may be such that they are lifted free of the engagement feature **158** of the arms **148**, thus allowing relative longitudinal motion between the driver assembly **142** and the implant **154**.

The driver assembly **142** and implant **154** described with respect to FIGS. **8-24**, may be used to distract a facet joint. With the delivery device **104** positioned as shown and described with respect to FIG. **7**, the implant **154** may be positioned to be held by the arms **148** of the driver assembly **142**. The driver assembly **142** and implant **154** may then be inserted into the delivery device **104** and slidably advanced such that the implant **154** is positioned between the forks **112** of the delivery device **104** and within the facet joint. The advanced position of the driver assembly **142** and implant **154** within the delivery device **104** may be most clearly seen in FIG. **13**. The proximal end of the driver assembly **142** may be tapped on to fully advance the driver assembly **142** and properly position the implant **154**. The implant shaft **146** of the driver assembly **142** may be prevented from rotating by the keyway feature **156** securing it against relative rotation with respect to the delivery device **104**. As such, once positioned, the distractor knob **144** of the driver assembly **142** may be turned, as shown in FIG. **25**, thereby advancing the internal actuator **152** and further advancing the implant distractor **150**. In the embodiment described, the coil-shaped thread feature **166** on the implant distractor **150** may engage the threaded slots **188** of the half-conical features **184** of the upper **168** and lower **170** members of the implant **154**. As such, the implant distractor **150** may be guided and remain in position to further engage the threaded slots **188** on the upper **168** and lower **170** members. As the implant distractor **150** continues to advance, those of skill in the art will understand and appreciate that its tapered shape advancing between the upper **168** and lower **170** members will force the upper **168** and lower **170** members of the implant **154** apart causing them to pivot about a point defined by the attachment to each other at their distal ends **174**. As the implant **154** continues to be distracted, the upper **168** and lower **170** members of the implant **154** are laterally separated such that they clear the engagement features **158** on the arms **148** of the driver assembly **142**. As shown in FIG. **26**, when the implant distractor **150** has been fully advanced and the implant **154** is in place, the driver assembly **142** may be slidably removed from the delivery device **104** leaving behind the implant distractor **150** and the implant **154**.

FIG. **27** shows yet another device, the device being adapted for placing bone paste over the implant **154** in the joint. An injector **202** is shown and includes a syringe type cannula **204** with a closed distal end **206** and two exit doors **208** positioned on opposite sides of the distal end **206** of the cannula **204**. The cannula **204** includes a plunger **210** with a seal and further includes a stopping disc **212** at its proximal end, the plunger **210** penetrating the stopping disc **212** and having a handle **214**. The cannula **204** may have an outer radius substantially equal to that of the inner radius of the delivery device **104** to allow for slidable engagement of the two devices. The disc **212** at the proximal end is generally flat and is adapted to engage the receiving assembly **110** of the delivery device **104** and provide a stop point for the injector **202** when inserted into the delivery device **104**. As shown, the cannula **204** may contain a bone paste material in a liquid form.

As shown in FIG. **28**, the injector **202** may be inserted into the delivery device **104** and slidably advanced such that the distal end **206** is near the implantation site and the disc **212** abuts the annular ring **118** of the receiving assembly **110** of the delivery device **104**. The injector **202** may be rotatably positioned such that the doors **208** are positioned to open perpendicular to a line connecting the distal ends of the forks **112**. The disc **212** may include tabs **216** for such positioning relative to the annular ring **118** on the receiving assembly **110**. Once in position, the plunger **210** may be actuated to compress the bone paste material creating an internal pressure which forces the exit doors **208** open allowing the bone paste to escape and flow over the implantation site.

The above description has included some references to use to allow for a better understanding of the structure. Below is a more detailed discussion of that use including the devices and techniques for distracting and retaining a facet joint in a distracted and forwardly translated condition. The implantation procedure may be performed under conscious sedation in order to obtain intra-operative patient symptom feedback.

Initially an incision may be made in the patients back. Tools known in the art may be used to create this incision and to open an access path through the tissues of the back to access the spine. Once an access path is created, the chisel **108** described above may be inserted into the delivery device **104** and the two of them may be inserted through the incision and the distal tip **130** may be positioned adjacent the target facet joint. It is noted that visualization may be provided by first inserting a scope down the delivery device **104** rather than the chisel **108**. Additionally, an incision in the facet joint capsule may be made prior to beginning the procedure, and thus prior to insertion of the chisel **108**. Once the distal tip of the delivery device **130** is properly positioned adjacent the facet joint and any other preparation steps are completed, the chisel **108** may be inserted. Once the chisel **108** and delivery device **104** are properly positioned, the head **132** of the chisel **108** may be tapped with a driving device **140** such as a hammer or other instrument to advance the distal tip **130** of the chisel **108** and the forks **112** of the delivery device **104** into the facet joint. Once the delivery device **104** is properly positioned, the chisel **108** may be removed. At this point, the implant **154** may be placed in the driver assembly **142** and the implant **154** and driver assembly **142** may be slidably advanced through the delivery device **104**. The forks **112** of the delivery device **104** may be holding the facet joint slightly distracted. As such, the implant **154**, in its flat and parallel position, may slide relatively easily into the facet joint. To the extent that it does not, the proximal end of the driver assembly **142** may be tapped to properly advance and position the implant **154**. Once properly positioned, the distractor knob **144** on the driver assembly may be rotated or otherwise actuated to activate the internal actuator **152**. The internal actuator **152** advances the implant distractor **150** into the implant **154** and thus distracts the implant **154**. It is noted here that the distraction of the implant **154** may cause the upper **168** and lower **170** member of the implant **154** to clear the engagement features **158** of the holder arms **148** thus allowing the driver assembly **142** to be freely removed from the delivery device **104** leaving the implant **154** and the implant distractor **150** behind. The injector **202** may then be advanced through the delivery device **104** and positioned to allow the doors **208** to open in a direction approximately perpendicular to the forks **112** of the delivery device **104**. The handle **214** may be depressed thus advancing the plunger **210** and ejecting the bone paste or other anchoring material. The injector **202** may then be removed. The delivery device **104** may also be removed and the incision closed.

Those skilled in the art will understand and appreciate that several modifications or variations from the above the identified embodiments may be made while still falling within the scope and spirit of the present disclosure. For example, several alternative actuation mechanisms at the proximal end of the tool for actuating the distracting elements of the tool may be available. Additionally, several alternative implants may be available. For example, as shown in FIGS. **29** and **30**, an implant **218** similar to that previously described is shown and includes a body **220** and a screw **222**. The body **220** includes an upper **224** and lower **226** face joined together at a leading end **228** and separated from each other at a trailing end **230**.

As shown in FIG. **29**, when the screw **222** is not received in the body **220**, the upper **224** and lower **226** faces may reside against each other such that the body **220** is generally flat. As shown in FIG. **30**, when the screw **222** is received in the body **220**, the upper **224** and lower **226** faces may be separated from each other, the degree of separation increasing as the screw **222** is increasingly received in the body **220**. As the upper **224** and lower **226** faces are separated from each other, the body **220** takes on more of a wedge shape, with the leading end **228** being the narrow end of the wedge and the trailing end **230** being the wide end. The faces may include teeth **232** and the trailing end **230** of the upper face **224** may be formed to project towards the leading end, both of these features assisting in the implant **218** anchoring to the bone facet surfaces. Holes **234** may exist in the faces **224**, **226** such that when the screw **222** is received in the body **220**, the thread edges of the screw **222** may project through the holes **234** to bite into the facet surfaces. The wedge shape of the implant **218** may facilitate anchoring the implant **218** within the facet joint and may also facilitate distraction, translation, or subluxation of the facet surfaces relative to each other.

As can be understood from FIG. **29**, the collapsed and flattened body **220** may be placed between the opposing surfaces of the facet joint. The posterior or trailing end **230** of the body **220** is configured to be capable of receiving a screw, bolt, or some other inserted component **222**. As indicated in FIG. **30**, upon insertion of the screw, bolt, etc. **222**, the body **220** begins to expand. This expansion and separation is enabled by a hinge **236** at the anterior or leading end **228** of the body **220**. As the body **220** expands, sharp directional teeth, cleats, or keels **232** on the opposing (superior & inferior) surfaces or faces **224**, **226** of the body **220** may become anchored in the cortical bone of the opposing facet surfaces. These teeth, cleats, or keels **232** may engage the facet surfaces and provide acute fixation of the body **220** within the facet joint. The teeth, cleats, or keels **232** may be included on only one surface **224**, **226** as opposed to both surfaces **224**, **226** so as to allow for a movement of the joint after placement of the implant **218**.

The distraction and separation of the facet joint via the expanded implant (see FIG. **30**) may increase foraminal area and reduce the symptoms associated with nerve root compression.

Another implant embodiment is depicted in FIGS. **31** and **32**, wherein a screw **238** also acts to spread apart the faces **240**, **242** of the body **244** of the implant **236**. In this embodiment, the implant **236** may have an upper **240** and a lower **242** member positioned adjacent to each other. The upper **240** and lower **242** member may be substantially rectangular with a distal edge a proximal edge and parallel lateral edges. The distal edge may be slightly radiused. The upper **240** and lower **242** members may be connected along their distal edge by a connection member **246** in the form of a triangularly bent plate or other connection. The connection member may include a penetration **248** adapted to receive an implant distractor **238**. As with the previous embodiments, the implant **236** may include teeth **250** on the outer surface of the upper member **240** or the lower member **242** or both as shown. In one embodiment, the implant **236** may be formed from a single plate and folded to create the shape shown. In use, the implant **236** may be positioned in a facet joint and the implant distractor **238** may be advanced thereby separating the upper **240** and lower **242** member and distracting the joint. Similar to that discussed above with respect to FIGS. **29** and **30**, such an embodiment as depicted in FIGS. **31** and **32** may have holes (not shown in FIGS. **31** and **32**) in the body surfaces **240**, **242** so as to allow the threads of the implant distractor **238** to extend through the surfaces of the body **244** to bite into the facet surfaces.

FIGS. **33** and **34** depict isometric views of another implant **248** with V-shaped members **250** residing on a threaded bolt **252** between an anterior threaded block **254** and a posterior non-threaded block **256**. The V-shaped members **250** may slidably engage the bolt **252**. As shown in FIG. **33**, the V-shaped members **250** are in a non-expanded state and are spaced apart from each other along the length of the bolt **252**. The implant **248** may be inserted into the facet joint in the non-expanded state depicted in FIG. **33**. As can be understood from FIG. **34**, the bolt **252** may be rotated to cause the anterior threaded block **254** to travel along the bolt **252** towards the posterior non-threaded block **256**. It is noted that in use, the rotation of the blocks **254**, **256** may be prevented by their position within a facet joint, thus causing the anterior threaded block **245** to travel rather than rotate when the bolt **252** is rotated. The posterior non-threaded block **256** may be in abutting position against the head **258** of the bolt **252** thereby preventing it from moving away from the anterior thread block **254**. Thus, as the anterior threaded block **254** advances toward the posterior non-threaded block **256**, the V-shaped members **250** are squeezed together. As the V-shaped members **250** are increasingly squeezed together between the blocks **254**, **256**, the V-shaped members **250** are increasingly expanded outward, thereby biting into the facet joint surfaces to anchor the implant **248** in the facet joint and distract, translate and/or subluxate the facet surfaces relative to each other.

FIGS. **35-36** and **37**A-D, depict isometric views of another implant **260** with planar plates or leaves **262** residing on a threaded bolt **264** and parallel shafts **266** between an anterior threaded block **268** and a posterior non-threaded block **270**. As shown in FIG. **35**, the planar plates **262** are in a skewed non-expanded state and are spaced apart from each other along the length of the bolt **264** such that may lie generally flat or, more specifically, at approximately 45 degrees on the bolt **264** and shafts **266**. The plates **262** may include a slotted hole for receiving the bolt **264**, which allows for the position described. The implant **260** may be inserted into the facet joint in the non-expanded state depicted in FIG. **35**. As can be understood, the bolt **264** may then be rotated to cause the anterior threaded block **268** to travel along the bolt **264** towards the posterior non-threaded block **270**, thereby causing the planar plates **262** to squeeze together. As the planar plates **262** are increasingly squeezed together between the blocks **268**, **270**, the planar plates **262** are increasingly expanded outward or, more specifically, are caused to be generally perpendicular to the bolt **264** and shafts **266**. As a result, the planar plates **262** bite into the facet joint surfaces to anchor the implant **260** in the facet joint and distract, translate and/or subluxate the facet surfaces relative to each other.

FIGS. **37**A-D show an embodiment, which combines features of the embodiment shown in FIGS. **33** and **34** with features of the embodiment shown in FIGS. **35** and **36**.

FIGS. **38**A-C shows another embodiment of an implant **272**. The implant **272** may include two stacked structures **274** that interface along a plane **276**. Each structure **274** may include opposing ratchet teeth **278** along the plane. The position and orientation of the ratchet teeth **278** may be such that relative translation between the two structures **274** is allowed when a force is applied to each structure **274** in opposing directions. That is, once the implant **272** is properly positioned within the facet, a device may be use to apply a force to the superior structure **274** which causes forward translation of that structure **274** relative to the inferior structure **274**. The ratchet teeth **278** on the superior structure **274** may slide up the slope of the teeth **278** on the inferior structure **274** until opposing apexes of teeth **278** pass by each other causing the two structures **274** to nest in a new relative position, the displacement being equal to the length of the teeth **278**. Each structure **274**, or only one of the structures **274**, may increase in thickness along its length, such that continual relative ratcheted displacement creates a greater overall thickness. The increasing thickness of the implant structures **274** may cause distraction and forward translation in the facet joint. The opposing facet surfaces may be separated and the superior vertebra may be pushed anterior relative to the inferior vertebra. In addition, anchoring teeth **280** may be provided on the outer surface of both structures **274** of the implant **272** to provide acute fixation to the articular surfaces. The implant **272** may be configured in a number of different shapes including, but not limited to, a wedge, a double wedge, a rectangular box, and "v" shaped.

FIGS. **39**A-D show another embodiment of an implant **282**. In this embodiment, a screw like implant **282** may be inserted between the facet. The insertion of this screw may serve to distract the joint surfaces resulting in a decompression of the nerve root. Additionally, the threads **284** of the screw may include V-shaped notches **286** in the threads **284** spaced throughout the length of the screw creating serrated teeth. As the screw implant **282** is threaded progressively further anterior, the serrated teeth may cut/bore into the cortical bone of the opposing facet surfaces. The defect in the bone these serrations produce may prevent the implant **282** from backing out posteriorly or migrating medial/lateral because the threads **284** are configured with the serrated teeth to allow the implant **282** to catch or "bite" in the bone if any posterior withdraw or backing out occurs. Additionally or alternatively, as shown in FIGS. **40**A-C, the screw threads **284** may include a leaf spring **288** to maintain friction of the threads **284** against the newly cut threads in the bone thereby preventing the screw from backing out.

FIGS. **41**A-D show another embodiment similar to the one shown in FIGS. **39**A-D. That is, in this embodiment, the implant **290** may take the form of a screw, but the threads **292** of the screw may have a T-shaped profile as shown in FIG. **41**D. In addition, the flat surface of the T-shaped profile may define a diameter at any given point along the length of the screw. In one embodiment, the diameter may increase over the length of the screw and not be limited to just the tip like a traditional screw. As such, when the implant **290** is placed, the more it is advanced into the facet joint, the more separation it creates.

FIGS. **42**A-F show another embodiment of an implant **294**. In this embodiment, the implant **294** may again take the form of screw. The screw may have a washer or extra broad head **296** with sharp protrusions **298** on the distal surface of the head **296** that engage the superior and inferior lateral mass surfaces as the screw is inserted into the facet joint. The engagement of the sharp protrusions **298** may occur as a result of both the longitudinal translation of the screw together with the rotational motion causing the sharp protrusions **298** to cut into the lateral mass surface as the screw is advanced and rotated. As the washer **296** rotates, the sharp protrusions **298** roughen the lateral masses and create a fracture environment. This fracture environment causes osteoblastic activity that will lead to bone production and assist in fusion of the joint at the lateral mass. Moreover, the moat created by the rotating and cutting protrusions **298** may begin to lock the facet surfaces together.

In the present embodiment, the protrusions **298** may be tab like and cut relatively deeply into the lateral mass. In addition as shown in FIGS. **42**D-F, the tabs may position themselves as shown where the superior tab is flared to engage the lateral mass and the inferior tab is wedged into the joint. In this configuration, the tabs may act to further distract the joint beyond that provided by the diameter of the screw portion of the implant. In other embodiments, as shown in FIGS. **43**A-C, the sharp protrusions **300** may be sharp prongs or spurs adapted to roughen the surface.

FIGS. **44**A-D show another embodiment of an implant **302**. In this embodiment, a facet distraction implant **302** has a floating collar **304** for use with a screw type implant. As shown, the collar **304** may be positioned to pivot about the head **306** of the screw due to the spherical shaped head **306** on the screw in a ball and socket fashion. The floating collar **304** allows the screw implant to accommodate irregular, non-planar surfaces of the lateral mass and may aid in the prevention of reverse threading of the implant **302** once the screw has been advanced to the proper position within the facet. As shown, the screw may be implanted to provide distraction and forward translation of the joint. The floating collar **304** may include teeth or spikes **308** that roughen/decorticate the cortical bone of the superior and inferior lateral masses resulting in the creation of a fracture environment. This may improve the chance of posterior lateral mass facet fusion.

FIGS. **45**A-D show yet another embodiment of a decorticating screw type implant **310**.

FIGS. **46**A-D show another embodiment of an implant **312**. In this embodiment, a structural implant **312** is inserted between the opposing surfaces of a facet joint. This implant **312** may be in the form of a screw as described above or may be a different implant requiring a torque or other force to be applied to anchor the implant **312** in the facet joint. As shown, when the implant **312** is inserted increasingly more anterior within the facet, a torque limiting mechanism **314** within the device may measure the force or torque applied to the system. Once a predetermined value of torque or force is achieved, the distal end of the system may detach causing the implant **312** to become a permanent distraction implant.

In the case of a screw implant, the torque limiting mechanism **314** may be a necked down portion of the device creating a calibrated weakened portion intended to fail when a specified torque is exceeded.

In this embodiment, the implant **312** may also include a number of anit migration features to prevent backout. These features may include directional teeth, roughened surfaces, keels, spikes, or other features known in the art. As with other implants, the geometry of the implant may cause distraction of the joint and lead to a more pronounced forward translation of the joint as the opposing facet surfaces separate.

FIGS. **47**A-B show another embodiment of an implant **316**. In this embodiment, again a screw shaped implant **316** may be inserted into the facet to distract the facet surfaces and increase foraminal height resulting in a decompression of a symptomatic nerve root. In this embodiment, however, the implant may include two main components. First, the implant **316** may include a relatively stiff but malleable cone-shaped screw structure **318** with aggressive threads for biting into the opposing surfaces of the facet joint. These threads may have a number of variations for preventing movement of the implant after it is implanted. Second, the implant may include an inner core support member **320**. The core support member **320** may be in place when the implant **316** is placed to assist in maintaining the shape of the screw structure **318**. After placement, the core support member **320** may be removed. The malleability of the screw structure **318** may allow it to collapse slightly once the implant **316** is properly positioned and inserted. The collapsing of the screw structure **318** would change the alignment of the threads and prevent reverse threading that could lead to posterior migration.

Yet another embodiment is show in FIGS. **48**A-C. In this embodiment, a superior **324** and an inferior **326** screw may be used to create an implant **322**. The two screws **324**, **326** may have communicative threaded serrations that work in opposition to one another. As such, when the inferior screw **326** is rotated, the threads may interact with the superior screw **324** causing it to rotate in the opposite direction. Moreover, the threads on the inferior screw **326** and superior screw **324** are such that opposite direction rotation draws both screws **324**, **326** in to the facet joint. As the screws **324**, **326** enter the joint, the facet surfaces are distracted apart from one another and the threads of the screw bite into the facet surfaces. The opposing rotation of the two screws **324**, **326** may also assist in preventing back out of the implant or reverse threading/unscrewing. It is noted that several configurations may be used to create the opposite rotation of the screws. In one embodiment, a housing may be placed over each screw allowing the screws to freely rotate relative to the housing, but securing the screws adjacent to one another. In this embodiment, the opposite rotation may occur due to the threads engaging with one another as described above or the screw heads may have gear teeth for engaging one another and causing opposite rotation. In another embodiment, the screws may have gears on them positioned within the housing to engage one another and cause opposite direction rotation.

FIGS. **49**A-C show yet another embodiment of an implant **328**. In this embodiment, a translating system including a vertical plate **330** and a bumper **332** may be included. The superior aspect **334** of the bumper **332** may have a rounded concave surface for opposing the lateral mass of a superior vertebra. The translating system may be secured by anchoring a screw **336** to the lateral mass of an inferior vertebrae. The screw **336** may act as the foundation for a bumper system intended to push a superior vertebra forward (anterior) creating translation of the superior vertebra relative the inferior vertebra. This forward translation may create an increase in foraminal area and results in a decompression of the nerve root. The implant **328** may be configured to maintain permanent forward translation in order to prevent foraminal narrowing and nerve root compression. In addition, the implant **328** may provide rigid resistance when the superior vertebra exerts posterior translation vectors because it is anchored by the inferior lateral mass screw. The prevention of this posterior translation may keep the segment in a state of forward translation and preserve the associated increase in foraminal area.

FIGS. **50**A-B show another embodiment of an implant **338**. In this embodiment, a wedge shaped or triangular implant **338** may be inserted between the face surfaces. The angled/pointed portion **340** with two acute line segments may allow the implant **338** to enter into the flat facet joint when sufficient force is applied. As the implant **338** is inserted progressively more anterior, the distraction of the opposing facet surfaces may increase. This separation results in an increase of foraminal height and decompresses the symptomatic nerve root.

The surfaces of this implant **338** may include teeth, spikes, cleats, surface roughening, and/or keels **342** to help prevent migration or backout. In another configuration of this embodiment, as shown in FIGS. **51**A-B, the wedge shaped or triangular implant **338** may be anchored in position by one or two (one shown in FIG.) lateral mass screws/nails **344** that would connect the superior & inferior aspects of the implant **338** to the corresponding superior & inferior lateral masses of the affected segment.

FIGS. **52**A-C show another embodiment of an implant **346**. In this embodiment, a distraction/translation system may include an anterior hook **348** and a posterior hook **350** joined by a threaded bolt **352**. The anterior hook **348** may be placed over the anterior aspect of the inferior facet and the posterior hook **350** may be positioned posterior to the superior facet. The anterior hook **348** may have a C-shaped profile with a lip for engaging the anterior aspect of the inferior facet. The posterior hook **350** may have a S-shaped profile with a lip for engaging the posterior aspect of the superior facet. The threaded bolt **352** may be positioned through the facet joint and may threadably engage a posterior leg **354** of the anterior hook **348** and an anterior leg **356** of the posterior hook **350** as shown. As the bolt **352** is tightened and the hooks **348**, **350** are drawn together, they create anterior translation of the superior vertebra relative to the inferior vertebra. This translation may result in increased foraminal area and nerve root decompression. The translation is maintained through the permanent placement of the hooks and bolt.

FIGS. **53**A-C show another embodiment of an implant **358**. In this embodiment, an insert **360** may be placed in the facet joint between two opposing facet surfaces. The geometry of the implant **358** could take a number of shapes including, but not limited to, rectangular, conical, triangular, or trapezoidal shape. Once the implant **358** is properly positioned, it may then be rotated some degree of rotation. This rotation may result in an increased height of the implant and cause facet surface separation and thus increased foraminal area and decompression of the symptomatic nerve root. In another configuration as shown in FIG. **53**C, the rotated implant **358** may have outer tabs **362** that are capable of receiving a bone screw, nail, or pin that can be anchored in the superior and inferior lateral masses. These tabs **362** and anchors may assist in the prevention of implant migration leading to a reduction in the foraminal area.

FIGS. **54**A-C show another embodiment of an implant **364**. In this embodiment, an implant **364** may take the form of a collapsible diamond shape **366** with an adjustment bolt **368** abutting a first corner **371** and threaded through an opposing corner **370** of the shape. The other corners **372** may include pads **374** for positioning against opposing articular faces of a facet joint. The implant **364** may be placed into the facet joint in a collapsed position and the adjustment bolt **368** may then be actuated to draw the opposing corners **371**, **372** of the shape together thereby expanding the shape and pressing the pads **374** against the articular faces. As the shape expands, additional facet distraction is achieved resulting in an increased foraminal opening. This implant **364** may be provided in a number of geometries or materials to provide directional distraction where, for example, more distraction occurs near the posterior edge of the facet relative to the anterior edge of the facet. Additionally, the surface of the pad **374** may include teeth or keels to enable bone purchase in the facet.

FIGS. **55**A-C show another embodiment of an implant **376**. In this embodiment, the implant **376** may take the form of an expandable hinged structure with an upper member **378** and a lower member **379** connected at their distal ends **380** by a hinge **382**. The implant **376** may be placed between the facet surfaces in a collapsed state. The posterior aspect of the implant **376** may include a receiving slot that is able to receive a screw, bolt, or other activation system. Engaging this slot with an activator would cause the implant **376** to expand on its hinge **382** creating distraction and translation of the joint. For example, the activator may be a wedge, a turnable flat tool, a tapered screw, or any other device that may be inserted into the receiving slot to forcibly expand the upper **378** and lower **379** members. As shown, the hinge **382** may also include a brace member **384** for maintaining the posterior halves of the hinge in a separated position. The brace member **384** may be spring loaded or otherwise engaged with the hinge halves **378**, **379** such that when expanded the brace **384** moves into position to support the open position of the hinge **382**. In some embodiments, the upper **378** and lower **379** member of the implant **376** may have teeth, cleats, or keels **386** to engage the cortical bone of the opposing facet surfaces. These mechanisms would provide fixation of the implant **376** to the joint.

FIGS. **56**A-C include another embodiment of an implant **388**. In this embodiment, a collapsed and flattened structure **390** may be placed between the opposing surfaces of the facet joint. The posterior aspect **392** of the structure **390** may be configured to be capable of receiving a screw, bolt, or some other inserted component **394**. Upon insertion of the screw, bolt, etc. **394**, the structure may begin to expand. This expansion and separation may be enabled by a hinge **396** at the anterior aspects of the structure **390**. As the structure **390** expands, sharp directional teeth, cleats, or keels **398** on the opposing (superior & inferior) surfaces of the structure may become anchored in the cortical bone of the opposing facet surfaces. These teeth, cleats, or keels **398** may engage the face surfaces and provide acute fixation of the structure within the facet joint. Together with the these teeth, cleats, or keels **398**, or as an alternative to them, as shown, the proximal end of the implant **388** may also include flanges **400** that overlap the lateral mass of the facet joint. These flanges **400** may include holes **402** for anchoring the implant **388** to the superior and inferior facet masses, or to only one of the masses. In a related embodiment, the superior and inferior surfaces may have open ports **404** that enable the screw threads to exit the structure and gain purchase in the opposing facet surfaces. The distraction and separation of the joint may increase foraminal area and reduce the symptoms associated with nerve root compression.

FIGS. **57**A-C show yet another embodiment of an implant **406**. In this embodiment, the implant **406** may resemble a screw and wall anchor. The wall anchor portion **408** may be generally cylindrically shaped and include two half sections **410** separated by a slot or it may include a multitude of longitudinally extending sections **410**. These sections **410** may be connected together at the tip **412** as shown or they may be connected together at the proximal end **414** of the implant **406** and at the tip **412** and may include several connections along the length of the implant **406**. The implant **406** may have a sharp, triangular or conical tip **412** that allows for access into the flattened facet joint. Once the implant **406** is inserted into the facet surface, a screw, bolt, or other insertion component **416** may be inserted into the implant **406**. As this component **416** is advanced the sections **410** may expand creating additional separation of the joint and allowing for measured distraction of the space. The sections **410** of the wall anchor portion **408** may include sharp directional teeth, cleats, or keels **418** that engage the cortical bone of the opposing facet surfaces.

FIGS. **58**A-B show yet another embodiment of an implant **420**. In this embodiment, a tool **422** may be used to apply a force to the superior vertebra of a motion segment. This forward translation would result in an increase in foraminal area and reduced nerve root decompression. Following the forward translation of the motion segment, an angled screw **424** would be placed through the superior facet surface, facet capsule, and inferior facet surface. This screw **424** would provide temporary immobilization of the joint which leads to fusion.

FIGS. **59**A-B show yet another embodiment of an implant **426**. In this embodiment, a collapsed, triangular shaped implant is inserted into the facet. The implant **426** may include a central shaft **428** and two or more springing leaves **430**. The leaves **430** may be connected to the distal end of the shaft **428** and may extend proximally along the shaft **428**. The leaves **430** may be connected at the distal end so as to be biased in a direction to form an arrow shape. The leaves **430** may be held in the compressed state by an insertion & delivery tool **432**. The delivery tool's compression of the implant **426** prevents the superior and inferior surfaces of the implant **426** from springing open to a distracted position. Once the compressed implant **426** is positioned correctly, the delivery tool **432** may be removed. Removing the tools causes the leaves **430** to open/expand causing distraction and separation of the facet joint thus resulting in increased foraminal area and reduced nerve root compression.

FIGS. **60**A-B show yet another embodiment of an implant **434**. This concept has at least three embodiments. The first embodiment consists of a direction facet joint screw **436** that is advanced through an inferior facet until it makes contact with the opposing superior facet. Once the screw **436** makes contact with superior facet surface, the energy applied to advance the screw **436** results in distraction and separation of the joint due to bearing of the screw tip **438** on the underside of the superior articular surface. In one variation of this embodiment, the hole for the screw in the inferior facet may be pre-drilled. When the screw is installed and encounters the superior facet, the screw may bite into the superior facet as it forces the fact upward and distracts the joint. Alternatively, in this embodiment, the screw may have a blunt tip **438** to distract the joint without biting into the superior facet.

In the second embodiment, as shown, a directional facet screw **436** may be advanced through the inferior facet surface until it engages with a facet spacer/plate **440** that is inserted in between the facet surfaces within the facet capsule. As the screw **436** makes contact with the facet spacer/plate **440**, the flat surface of the spacer/plate **440** may push up against the opposing superior facet surface causes distraction and forward translation. This separation of the facet surfaces results in increased foraminal area and reduced nerve root compression.

In a third embodiment, the spacer/plate **440** may have a shape to allow the screw **436** to pass through a first end and the other end to be placed in the facet joint. In this embodiment, the C-shaped spacer **440** may be positioned in the joint, thereby slightly distracting the joint. The screw may then penetrate a first end of the spacer **440** thereby anchoring the spacer **440** in the joint. The screw may then be advanced through the inferior facet surface until it engages with the spacer/plate **440**. As the screw **436** makes contact with the facet spacer/plate **440**, the flat surface of the spacer/plate **440** may push up against the opposing superior facet surface causes distraction and forward translation. In some embodiments, the screw may penetrate the spacer and aid in fixing the joint.

FIGS. **61**A-C show yet another embodiment of an implant **442**. In this embodiment, bracket type structures **444** may be attached to the superior and inferior lateral masses. The bracket type structures **444** may enable the attachment of a single bolt **446**. The bolt **446** may be configured to create a distraction energy. That is, it may be connected to the inferior bracket **444** to allow rotation but not relative translation. In contrast, the bolt may threadably engage the superior bracket **444**. As such, when the bolt **446** is "unscrewed" it may function to push the inferior and superior brackets **444** apart. This distraction may result in increased foraminal area and reduction in nerve root compression.

FIGS. **62**A-C show yet another embodiment of an implant **448**. In this embodiment, bracket type structures **450** may each have a leg **452** for positioning within a facet joint and another leg **454** for receiving a bolt **456**. As with the bracket above, the bolt **456** may be configured to create distraction energy. That is, it may be connected to one of the superior or inferior bracket **450** so as to allow rotation but not relative translation. The other bracket **450** may threadably engage the bolt **456**. As such, when the bolt **456** is "unscrewed" it may function to push the brackets apart resulting in and increased foraminal area.

FIGS. **63**A-C show yet another embodiment of an implant **458**. In this embodiment, a triangular shaped implant **458** including a bent plate and a filler wedge may be inserted in the facet joint. As the triangular implant **458** is inserted progressively more anterior, the joint may be distracted to an optimal level. Once the desired distraction is achieved, an anchoring screw **460** may be inserted through the implant **458** and into the inferior lateral mass. The superior aspect of the implant **458** may include a metal flap **462** with teeth, spikes, or cleats **464**. This malleable flap **462** may be contoured to the superior lateral mass and anchored using its teeth, spikes, or cleats **464**. The metal flap **462** and inferior screw **460** may provide permanent fixation of the triangular implant **458** to enable permanent distraction of the facet and immobilization of the joint facilitating permanent fusion of the joint.

FIGS. **64**A-C show yet another embodiment of an implant **466**. In this embodiment, a distraction system consists of a central anchoring plug **468**, an initiating plate **470**, and two external plates **472**. The two external (superior and inferior) plates **472** may be attached to the lateral masses of a motion segment and may be anchored using screws. The initiating plate **470** may then be inserted in the gap **471** between the external plates **472** to initiate opening of the plates **472** and the joint and allow for further insertion of the anchoring plug **468**. Following the insertion of this initiating plate **470** and turning or manipulating the plate **470** to open the external plates **472**, the central anchoring plug **468** may then be advanced into the gap **471** between the external plates **472** causing expansion of the plates and distraction and separation of the joint.

FIGS. **65**A-C show yet another embodiment of an implant **474**. In this embodiment, nitinol hooks **476** may be configured to have a memory. The hooks **476** may be flattened and inserted through a delivery system **478**. The delivery system **478** may be placed in a facet joint. Once inserted within the facet, the nitinol hooks **476** may be activated via temperature, force, or other activation means causing them to assume their original (pre-flattened) shape and hook into the opposing facet surfaces. As the hooks **476** engage the cortical bone of the facet surfaces, they distract the joint. This separation results in increased foraminal area and reduced nerve root compression.

FIGS. **66**A-C show yet another embodiment of an implant **480**. In this embodiment, a hollow screw sleeve **482** may be placed within the facet joint. A wedge **484** may then be placed within the hollow screw sleeve **482** causing it to expand and distract the joint. Additionally, the screw sleeve **482** may include sharp barbs **486** having a refracted position and a ejected position. As the wedge **484** is inserted, the wedge **484** displaces the sharp barbs **486** causing them to be ejected through the screw sleeve **482** and engage the facet surfaces. These barbs **486** may provide acute fixation of the implant **480** to the joint and prevent migration of the implant **480**. The distraction and separation of the joint result in increased foraminal area and reduced nerve root compression.

FIGS. **67**A-C show yet another embodiment of an implant **488**. In this embodiment, a panel anchor implant **488** may be placed within the facet joint. The implant **488** may include a bolt **490** and collapsible nut **492** that is rotationally free from the bolt **490** near the head of the bolt **490** and threadably engaged with the bolt **490** near the end opposite the head. As such, when the bolt **490** is advanced, the distal end of the nut **492** is squeezed toward the proximal end of the nut **492** and the nut **492** may collapse with an accordion effect. As shown, the compression of the nut **492** results in a taller structure that applies a distraction force to the opposing facet surfaces. This distraction leads to increased foraminal area and reduced nerve root compression.

In similar fashion, the embodiment shown in FIGS. **68**A-C may collapse causing distraction of the joint. In lieu of the nut **492** shown in FIGS. **67**A-C, this embodiment, shows a flat plate **494** that collapses into an accordion shape.

FIGS. **69**A-C show yet another embodiment of an implant **496**. In this embodiment, an implant **496** is placed within the facet joint. The implant could have a number of shapes and sizes but, in this embodiment, has a tension wire **498** that surrounds the implant **496** and is pulled taught during implantation. Once the implant **496** is properly positioned, the wire's tension is released. The release of this tension causes the wire **498** to return to a preset expanded shape and height that causes the implant **496** to expand. The expansion of the implant **496** as the wire returns to its preset, and larger profile, shape causes separation of the facet joint. This distraction results in increased foraminal area and reduced nerve root compression.

Similarly, as shown in FIGS. **70**A-C, an implant **500** with an outer housing **502** and an internal spring **504** may be positioned in the facet joint with the wire spring **504** in a tensioned or elongated position. Once properly positioned, the tension on the spring **504** may be released thus collapsing the spring **504** and expanding the associated housing **502** of the implant **500**.

FIGS. **71**A-C show yet another embodiment of an implant **506**. In this embodiment screw type implant **506** may be provided and may also include an arm type locking mechanism **508**. The locking mechanism **508** may extend from all sides of the head of the screw as shown and may be biased in a distal direction. As the screw advances, the locking mechanism **508** may anchor in the lateral mass of a vertebra. The biased position of the arm **508** pressing against the lateral mass may provide a force biasing the implant **506** against the advancing direction. However, this may cause constant friction between any newly cut threads in the surfaces of the facet joint thereby preventing unscrewing or back out of the implant. In addition, teeth **509** may be included on the arms **508** and may bite into the lateral mass further preventing backing out of the implant.

FIGS. **72**A-C show yet another embodiment of an implant **510**. In this embodiment, two wedge shape opposing structures **512** are shown separated by a sloping plane **514**. The structures **512** may have a predetermined relative position, or a series of predetermined relative positions, where a bolt or screw **516** may be advanced at an angle as shown through one of the structures **512** and into a predrilled hole of the other **512** to maintain their relative position. Alternatively, the relative positions may not predetermined and a self-drilling screw **516** may be used. In either case, the implant **510** may be positioned in the facet joint in minimal profile position and then the two structures **512** may be slid relative to each other along the sloping plane **514** to expand the implant **510** and thus the facet joint. Once the desired position is achieved, the bolt, pin, screw, or other fastener **516** may be inserted to maintain the relative position of the structures **512**.

FIGS. **73**A-C show yet another embodiment of an implant **518**. In this embodiment, an implant **518** is configured to be inserted in a collapsed state. In its non collapsed state, it has a vertical cylindrical profile with side cutouts **520**. When the implant is compressed, the side cutouts **520** allow the wall panels **522** to bend out as the height of the cylindrical implant **518** is reduced. These wall panels **522** create an anchor shape that can engage bone structures. This implant **518** may be placed within the facet join in its flattened, compressed profile. Once it is positioned correctly, a distraction energy may be applied to the implant **518** to cause it to expand or decompress. This decompression causes the implant **518** to attempt to return to its vertical cylindrical shape. The implant **518** may be made from a resilient elastic material such as nitinol, stainless steel, or other known materials. As the implant **518** becomes more cylindrical, it pushes against the opposing facet surfaces. This force causes distraction of the facet joint and results in increase foraminal area and reduced nerve root compression.

Similarly, as shown in FIGS. **74**A-C, the implant **518** may be positioned on its side and the distraction energy may cause the implant **518** to collapse from its cylindrical shape and expand laterally to distract the facet joint.

FIGS. **75**A-B show yet another embodiment of an implant **524**. In this embodiment, a delivery tool **526** is inserted within the facet joint. The distal tip **528** of the delivery tool **526** is shaped to distract the joint. Once the tool **526** is inserted into the facet joint and the desired amount of distraction is achieved, the distal tip **528** (part that is in the facet joint) may be detached from the delivery tool **526**. In one configuration of this embodiment, the detachable tip **528** would have teeth, cleats, spikes, or keels **530** to prevent it from migrating within the joint once it is detached. In another configuration of this embodiment, the implant **524** may be anchored in the facet joint by inserting a screw **532** through the superior facet, the implant, and the inferior facet. In both configurations, the detachable tip **526** (implant) may provide permanent distraction of the joint resulting in increased foraminal area and reduced nerve root compression.

FIGS. **76**A-C show yet another embodiment of an implant **534**. In this embodiment, the implant **534** may include a housing **536** with a central gear **538** turnable by an Allen type head **540** or other known attachment for turning, such as any known screwdriver heads. Adjacent the central gear **538** on each side, the implant **534** may include two plates **542** slidable in the housing **536** in a direction tangential to the gear surface. The plates **542** may include teeth **544** engaging the central gear **538** such that when the gear **538** turns, the plates **542** slide tangentially to the gear **538** and extend beyond an outer surface of the housing **536**. As such, the implant **534** may be positioned in a facet joint as shown in FIG. **76**A. Once positioned, the gear **538** may be turned thus extending the plates **542** in opposite directions and distracting the facet joint.

FIGS. **77**A-C show another embodiment of an implant **546**. In this embodiment a triangular shaped implant **546** in the form of a bent plate **548** may be wedged into the facet causing distraction and separation of the joint. On one side of the triangular distraction structure **548** is a bracket **550** with a screw **552**. The screw **552** may be inserted into the lateral mass to provide anchoring of the facet distraction implant **546**. The other side of the triangular distraction structure **548** may include teeth or other features **554** for biting into the associated lateral mass. The implant **546** would provide permanent distraction of the joint resulting in increase foraminal area and reduced nerve root compression.

FIGS. **78**A-C show another embodiment of an implant **556**. In this embodiment, the implant **556** may have a tapered shape that is taller at the posterior aspect relative to the anterior aspect. The implant could be tapped in, malleted in, screwed in with threads, or pushed in with hand pressure. Once the implant **556** is positioned correctly, the head **558** of the implant **556** (posterior aspect) may be configured to have sharp teeth, spikes, or cleats that can be pushed into the cortical bone of the superior and inferior lateral masses of a motion segment. These flaps **558** could be hinged on the posterior aspect of the implant **556** to allow the flaps **558** to be pushed anterior enough to match the irregular contours of the lateral mass. The implant **556** would provide permanent distraction of the joint resulting in increase foraminal area and reduced nerve root compression.

FIGS. **79**A-C show another embodiment of an implant **560**. In this embodiment, the implant **560** includes a single rotatable cone **562** with a shoulder shaped ledge **564** defining a cam surface **566**, the distance between the ledge and the bottom of the implant defining a shoulder height. The shoulder height may vary gradually from low to high and back to low along the circumferential perimeter of the cone **562**. In use, the implant **560** may be initially positioned such that the shoulder portion with the low ledge height enters the facet joint. Once in position, the implant **560** may be rotated to cause the higher ledge height to enter the joint thereby distracting the posterior portion of the joint by causing the superior articular face to ride upward along the cam surface **566**. The implant **560** may then be secured with a screw **568** extending along the longitudinal axis of the implant.

FIGS. **80**A-D show yet another embodiment of an implant **570**. In this embodiment, an implant **570** may include a housing **572** with penetrations **574** adapted for ejection of retracted spikes **576**. Within the housing **572**, a wire **578** may be routed between the spikes **576** as shown in FIG. **80**D. The implant **570** may be inserted into the facet joint while the wire **578** is relaxed and the spikes **576** are contained within the folds/curves in the collapsed wire **578**. Once the implant **570** is positioned correctly, the wire **578** may be pulled taught causing the spikes **576** to displace outwardly, extending out of the housing **572** and engaging the opposing facet surfaces with a force. This force may create distraction and separation of the joint, while the pointed tips of the spikes **576** would penetrate the surface of the facet joint and provide acute fixation preventing migration of the implant **570**. The implant **570** would provide permanent distraction of the joint resulting in increase foraminal area and reduced nerve root compression.

FIGS. **81**A-C show yet another embodiment of an implant **580**. In this embodiment, an implant **580** may include a housing **582** with a cavity **584** and penetrations **586** on lateral surfaces extending from the cavity **584** through the wall of the housing **582**, the penetrations **586** adapted for ejection of retracted spikes **588**. Within the housing **582**, a threaded piston **590** may be positioned at a distal end and may be adapted for displacement through the cavity **584** in the proximal direction. The piston **590** may have a torpedo shaped distal end **592** and may engage the a beveled inner surface **594** of the retracted spikes **588**. The implant **580** may be positioned within a facet joint and when properly positioned, the piston **590** may be advanced via a turning tool, the torpedo shaped distal end **592** of the piston **590** thus engaging the beveled end **594** of the spikes **588** and advancing them laterally relative to the implant **580** out of the housing **582** with a force and into the face of the facets. This force may create distraction and separation of the joint, while the pointed tips of the spikes **588** would penetrate the surface of the facet joint and provide acute fixation preventing migration of the implant **580**.

FIGS. **82**A-F show yet another embodiment of an implant **596**. In this embodiment, the implant **596** may include two parallel equal length side bars **598** with pivoting struts **600** positioned on a pin **602** between the bars **598** at each end. The pivoting struts **600** may include textured surfaces **604** on each end and the struts **600** may be pinned to the side bars **598** through one end. As shown in FIG. **82**F, the struts **600** may have length so as to allow them to be pivoted to lie parallel to one another in the plane of the side bars **598**. In this position, the implant **596** may be positioned in the facet joint as shown in FIG. **82**A or anterior to the facet joint as shown in FIG. **82**D. Once properly positioned, the struts **600** of the implant **596** may be rotated so as to be approximately perpendicular to parallel side bars **598** thus separating an inferior vertebra from a inferior vertebra. It is noted that the generally stout shape of the struts **600** with relatively broad textured ends **604** may facilitate stability preventing the implant **596** from racking back to the parallel condition.

Another variation of this embodiment is shown in FIGS. **83**A-B, where a series of varying height struts **600** are positioned along a shaft. The entire implant may be placed within a facet joint on its side and then a single ninety degree turn may position the implant and distract the joint.

FIGS. **84**A-B show yet another embodiment of an implant **606**. In this embodiment, two rotatable cams **608** may be positioned in a facet joint. It is noted that the cams may have a relatively low profile and the proportions in the FIGS. may be exaggerated for purposes of showing the concept. Once placed in the joint, a distraction/rotation energy may be applied to the cams causing them to rotate open to reveal two circular halves of the cam implant. As one half of the implant rotates superiorly, it may push the superior vertebra upward creating an increase in foraminal area and nerve root decompression.

In another embodiment, a kit is provided. As shown in FIGS. **85** and **86**, the kit may include a delivery device **610**, a chisel **612**, several internal and external decorticators **614**, **616**, **618**, and a driver assembly **620**. As shown in FIGS. **87** and **88**, the chisel head **622** and shaft **624** may be provided in two pieces that may be combined with a press fit. As shown in FIG. **89**, the delivery device **610** may be provided in two pieces combinable with a press fit, the first piece being a tubular shaft and fork piece **626** and the second piece being a receiving assembly piece **628**. As show in FIGS. **90-93**, the driver assembly **620** may be provided in several pieces including the internal actuator and the implant shaft/arms/handle portion. FIG. **90** shows the shaft/arms/handle portion comprising two pieces, the first piece being a shaft with arms **630** and the second piece being the handle **632**. FIGS. **91** and **92** show the internal actuator including a tip **634**, a shaft portion **636**, an adapter **638**, a pin **640**, and a distractor knob **642**. In addition to the elements shown, one or several implants may be provided as well as an injector as previously described. Several traditional instruments for use in accessing the surgical site and closing the surgical site may also be provided.

Those of skill in the art will understand and appreciate that the implant embodiments depicted herein may be made of several types of biocompatible materials including stainless steel, titanium, ceramics, nitinol, polymers, and other materials known in the art.

The above description has included some references to use to allow for a better understanding of the structure. Below is a more detailed discussion of that use including the devices and techniques for distracting and retaining a facet joint in a distracted and forwardly translated condition. The implantation procedure may be performed under conscious sedation in order to obtain intra-operative patient symptom feedback. Before the facet joint can be distracted, however, the joint, which is difficult to access, must be accessed pursuant, for example, to a method and apparatus disclosed in U.S. provisional application Ser. No. 61/020,082, filed Jan. 9, 2008, which is commonly owned with the present application and hereby incorporated by reference. Pursuant to the disclosure in that application, the access system may include one or more cannulas made of steel, titanium, or plastic. The initial facet joint access cannula may have a sharp spatula tip on the distal end. The spatula tip may have a flat configuration to enable access into the flat facet joint. Once the spatula tip achieves access into the flatly oriented facet joint, subsequent stylets and working instruments may be passed down this access channel to complete a distraction procedure. Alternatively the chisel and delivery device described above may be used to access the joint. The distraction procedure may then begin.

The percutaneous distraction system may be introduced down the working cannula of the above-identified access system using a handle or delivery tool that would allow the surgeon to generate distraction by applying energy to the handle for a distraction device at the proximal end of the device.

A distraction device may be inserted down the working cannula, for example of the access system described previously, which is docked in a facet joint. Once the distal end of the distraction device is positioned at the anterior aspect of the joint, the surgeon applies energy to the distraction device to create separation and distraction of the facet joint. This separation occurs in both the vertical and horizontal planes of the joint resulting in vertical distraction and forward/anterior translation of the superior vertebrae relative to the inferior vertebrae. The facet joint distraction and forward translation will cause an increase in foraminal area and may reduce nerve root compression and associated symptoms.

Although the present invention has been described with a certain degree of particularity, it is understood the disclosure has been made by way of example, and changes in detail or structure may be made without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A spinal joint distraction system, comprising:

a driver assembly comprising:

a first tubular shaft having a longitudinal axis; and

first and second implant engagement faces positioned on a distal end of the first tubular shaft, each face configured to engage at least a portion of a spinal implant; and

a delivery device comprising:

a second tubular shaft defining a lumen;

a receiving assembly including the lumen for receiving the driver assembly, the receiving assembly positioned on a proximal end of the second tubular shaft; and

a pair of tines extending from a distal end of the second tubular shaft, the tines adapted to penetrate a facet joint,

wherein, the second tubular shaft slidably receives the driver assembly.

2. The spinal joint distraction system of claim **1** further comprising a chisel including a shaft having a proximal end and a distal end opposite the proximal end, the distal end including a tip.

3. The spinal joint distraction system of claim **2** wherein the tip of the chisel is a single or doubly chamfered tip.

4. The spinal joint distraction system of claim **2** wherein the shaft of the chisel is adapted to be received within an inner radius of the second tubular shaft.

5. The spinal joint distraction system of claim **1** further comprising a decorticator comprising a tubular shaft portion having a distal portion with an abrasive distal end.

6. The spinal joint distraction system of claim **5** wherein the abrasive distal end of the distal portion of the tubular shaft portion of the decorticator includes a plurality of teeth.

7. The spinal joint distraction system of claim **5** wherein the tubular shaft portion of the decorticator has a shaft adapted to be received by the second tubular shaft.

8. The spinal joint distraction system of claim **1** further comprising an implant received by the implant engagement faces, the implant comprising a first surface opposite a second surface, each of the first and second surfaces including teeth.

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